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CONTENTS.

	PAGE.
Editorial	549
The Paris Exposition of 1900	551
Balancing the Distribution in Multiple-Wound Armatures	552
Mr. Tesla's Paper Before the Electro-Therapeutic Society	552
The Transmission Plant Les Clees-Yverdon, by J. Laffargue	552
Short Cuts in Dynamo Calculations, by Cecil P. Poole	555
High Voltage Power Transmission, by Chas. F. Scott	557
Electrical Fakirs and the Lay Press	561
Digest of Current Electrical Literature, compiled by Carl Hering	562
The Dow Engine	566
A Serviceable Push Switch	568
Some New Telephone Apparatus	568
A Slow-Speed Laboratory Motor	568
Improved Flush Switch	568
Spring-Jack Drop and Coil for Telephone Express Switchboards	569
A Small Magneto	569
The Wright Discount Meter	569
Departments:	
Financial Intelligence	570
Special Correspondence	570
General News	572
Legal Notes	574
Personal Notes	574
Obituary Note	574
Trade and Industrial Notes	574
Business Notice	575
Illustrated Record of Electrical Patents	576

MULTIPHASE TRANSFORMERS.

A type of apparatus not made in this country, but quite generally used in European power-transmission plants, is the multiphase transformer. A good example of this machine is described and illustrated on page 554 of this paper. In this particular instance it is of the core type designed for three-phase working, each phase having but a single core instead of the two cores which would be necessary were three separate single-phase transformers used. The three cores are magnetically cross-connected at their ends by common laminæ and form a mutual common return for the lines of force between the two systems of end plates. The structural advantages obtained by this construction are instantly recognizable, three separate single-phase transformers such as would be used for the same service in this country requiring, if of the core type, six cores, six sets of end plates, six primary and six secondary coils, an exact duplication of the number of parts, although, of course, of smaller dimensions. The simplification, the advantages of insulation and the cheaper construction of the larger sizes per unit output are obtained by the union of the three transformers into one. The possibility of this union depends, of course, on the mutual relations of the three electromotive forces, the vectorial representations of which must form a closed triangle, which—translated into iron and copper—means that the lines of force set up in the three cores will at all instants exactly balance each other.

Multiphase transformers are also often made up in the shell type, and besides the advantages of increased size and reduced number of parts in this type there is or may be an immediate economy of iron, the three tongues of the shells, for example, serving as magnetic common returns and reducing the amount of iron needed to complete the magnetic circuit by as much as perhaps 25 per cent. In the case of the core type, illustrated in this issue, the fact that the three cores are a mutual common return is not only based on the principle that the vectorial representations of the three electromotive forces form a closed triangle, but in turn, neglecting the magnetic leakage, compels this condition. The same effect necessarily follows also from the delta connection of the three windings. By connecting the windings in a star or Y system, which necessitates that the currents in the three phases shall be mutually dependent, it is possible that such a multiphase transformer could be made to give a mutual balancing action much like that of a running synchronous or induction machine.

THE LIMIT OF LONG-DISTANCE POWER TRANSMISSION.

Ever since the now classic transmission of power from Lauffen to Frankfurt, 112 miles, those who believe that "electricity is still in its infancy," who are also, as a rule, those who have no comprehension of the difficulties involved in rearing the infant, have pictured future plants transmitting power from almost anywhere to anywhere else that their fancy or wishes may have inclined them, and particularly from Niagara Falls to New York and Chicago. Through the almost infinitely painstaking care of the engineering departments of the companies undertaking high-tension distribution the difficulties and dangers and breakdowns of such plants have gradually been reduced and eliminated until now 10,000 volts is an every-day matter, 20,000 is in some use, one plant of 40,000 is running, and apparatus, particularly transformers, has been built for pressure as high

as 100,000 or even 150,000 volts,[1] and transformers have been worked at 200,000 volts.[2] But at a point far below these pressures there seems to be an impassable limit, above which overhead lines cannot be worked, and this is clearly brought out in a paper prepared with great care and thoroughness by Mr. Charles F. Scott, read before the American Institute at the last general meeting at Omaha and reprinted in part on other pages of this issue. This limit is the loss of power through air leakage, probably a convective discharge from line to line. As is clearly indicated in Fig. 6 of that paper, which is shown on page 561, this discharge begins at pressures varying from about 40,000 volts, with the wires 15 inches apart to 50,000 volts with the wires 52 inches apart, and runs up so steeply with advancing pressure that in the case of a long line it would soon become a large percentage of the total power delivered, and so reduce the efficiency of the line that the diminished line loss, due to increasing voltage, would at a certain point become balanced by the increasing leakage, above which pressure any further increase would cause a loss instead of a gain.

An increase in the distance between wires helps some, as the curves show, but much more than 4 feet is not practicable with all wires on a single pole line. The question instantly arises, What could be done with a plurality of pole lines, one for each terminal or corner of the circuit? The increased distance between wires obtained in this way would be effective until it became approximately equal to double their elevation above the ground, when, of course, the latter would become a connecting link in the path of the leakage discharges. Another factor that might enter even with the wires at a considerable distance from each other on the same pole line is leakage through the air to poles and cross arms, and in case separate pole lines were used the static discharges to the poles in wet weather might readily become a serious bar. The high self-induction of circuits looped about such a great air space, as would be that between pole lines, is no longer a difficulty, since over-excitation at the receiving end can be made to introduce the equivalent of a capacity effect, by which the power factor of the circuit may be maintained near unity, even with a considerable inductance in the line.

In the present state of the art this leakage effect may be said to set a limit to high-voltage transmission at from 50,000 to 75,000 volts, which in turn sets a limit—taking the author's own figures of three miles per thousand volts—of profitable power transmission, with average relative cost of coal and water power, at distances of 150 to 200 miles.

The assumptions of loss and investment, however, must be proportioned to the ratio of the cost of power at the shaft of the proposed source and the cost at the point of consumption of the cheapest alternative source. In cases of extreme high cost of fuel and low cost of hydraulic equipment, a percentage drop, for example three times that assumed by Mr. Scott, or 50 per cent., might be justified, in which case the distance, with the same cost of copper, would be multiplied by the square root of three. As is also pointed out in the paper, the limitations depend largely on the amount of power delivered, owing to the fact that a large proportion of the total cost of a transmission line is the same, or very nearly the same, whether 100 or 10,000 kw is to be delivered. The right of way, the poles, the cost of management and of patroling, and perhaps the insulators, cost no more for a big load than for a small one. Transformers for extremely high-tension work can be readily built in 1000-kw sizes, where 100-kw units would be out of the question, owing to the great cost and high loss per kw output, in turn caused by the large proportion of the spaces next the iron needed for insulation.

[1] See The Electrical World of March 5, 1898, page 294.
[2] See Ibid., page 300.

The same paper discusses another subject about which little has been generally known, and that is, the relative advantages of porcelain and glass as a material for high-tension line insulators, the author stating in part: "I can see no advantage of porcelain over glass, unless it be that of superior mechanical strength." The rise of porcelain as an insulator has been a feature of high-tension work difficult to account for. Owing, perhaps, to the fact that its surface is less hygroscopic than that of glass, and therefore it is largely used on English and European telegraph lines, where great care is taken to get favorable electrical conditions for superior transmission of messages, it was considered essential for high-voltage lines as soon as they were undertaken. As a result of this hasty conclusion, the most strenuous efforts were made by porcelain manufacturers to overcome its great failings in this class of work, notably its porosity, and to obtain a homogeneous vitrification. These results accomplished, it is now announced that glass is as good as, or better than, porcelain. Looking at the matter from a purely analytical point of view, it is obvious that the chief failing of glass in telegraph insulation would be automatically corrected in high-tension work, since as soon as the moisture on its surface became sufficient to cause serious leakage it would be immediately vaporized by the heat generated from that leakage. Complete vitrification of glass throughout its whole mass is, of course, a matter of no difficulty, although the construction of a single body of glass of the size necessary for giving a long surface distance between wire and pin may be. For example, the 40,000-volt line used in the Provo-Mercur line is fitted with a glass insulator 7 inches diameter by 5½ inches high.

Another idea suggested by the experiences described is the improvement of the insulation by care in the electrical constants of the cross arms. As pointed out by Professor Fessenden in his paper presented to the Institute on "Insulation and Conduction,"[1] the insertion between two alternating-current, high-potential terminals of a dielectric not electrically homogeneous will cause greater strains than if but one dielectric were used with a lower specific inductive capacity. The use between two line wires of two glass or porcelain insulators and a wooden cross arm is exactly such a case. The high specific inductive capacity of the glass or porcelain causes charges to collect at each alternation on the pins and tend to travel over the cross arm with each reversal of the current. Mr. Scott states: "In every case in my experience where a breakdown has occurred it has been on a cross arm which was 'wind-shaken' or 'weather-cracked,' the current following the cracks," and also in describing a line running near the Pacific Coast he states that the burning of the cross arms is almost entirely on the side toward which the winds come from the ocean bearing a mist of salt water. A higher dielectric strength, ohmic resistance and specific inductive capacity in the cross arms might be a great aid to the insulators and can, of course, only be obtained by protecting the cross arms from moisture by means of a hood or roof, or shaping them in such a way that there would be dry surfaces on their structure protected by overhanging petticoats.

The use or proposed use of oil insulators has been quite outgrown in this country. Oil reduces the surface leakage, but surface leakage under the insulator is, as a rule, a source of less trouble than the jumping of the current from the edge of the outside moist petticoat to the pin, which oil does not of course prevent.

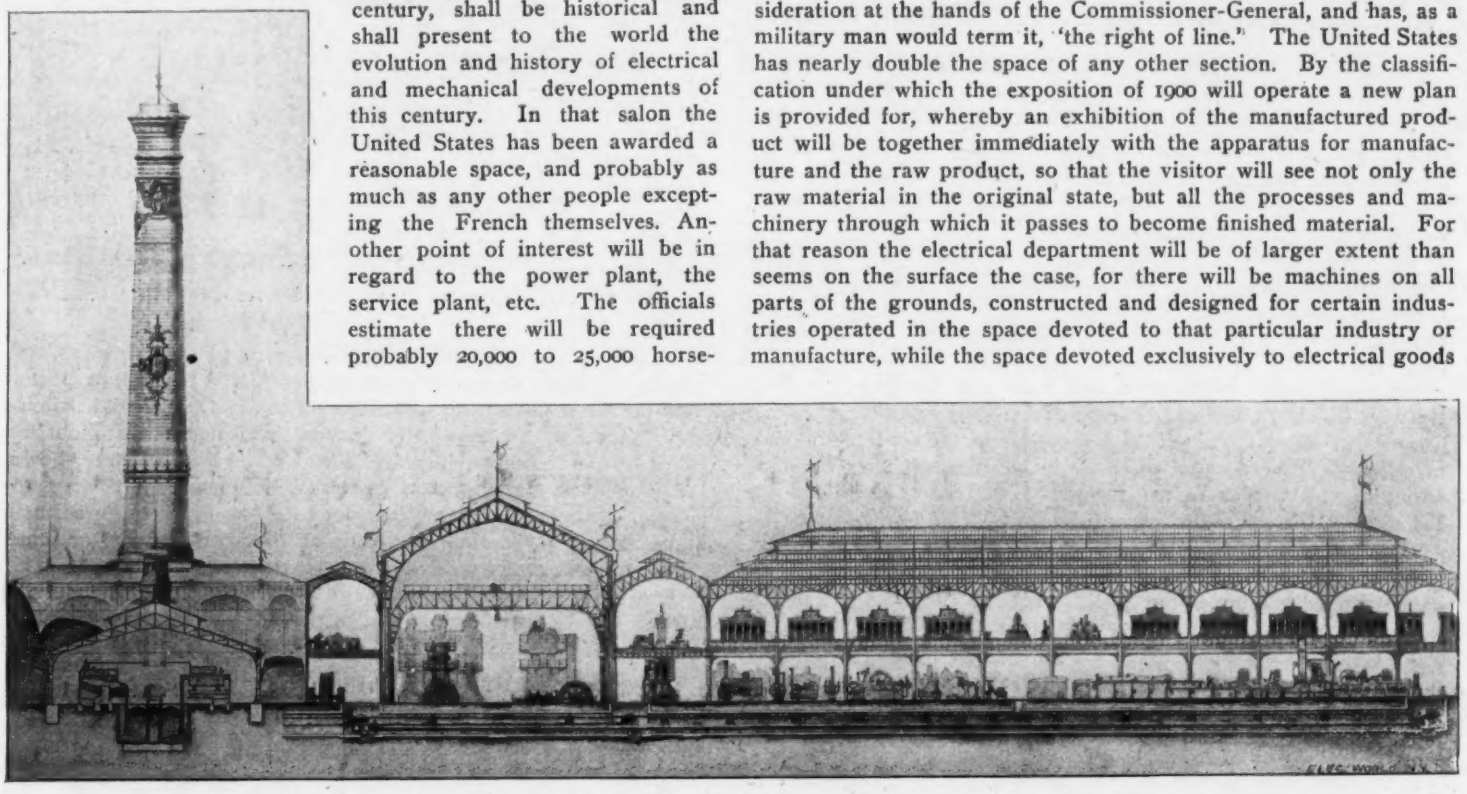
Whether or not the limit set by these luminous brush discharges can be exceeded by the use of conductors insulated not by the air, but by solid or liquid dielectrics, the future only can tell. The comparative high cost of such conductors, however, will probably fix the distances over which transmissions can be economically carried at limits as low, or lower, than those set by air leakage.

[1] See The Electrical World, April 2, 1898, page 415.

The Paris Exposition of 1900.

Mr. Francis E. Drake, director of machinery and electricity for the United States Commission of the Paris Exposition of 1900, has just returned to New York from Paris, where he has been since the middle of September, looking after affairs in connection with the United States exhibit that come under his jurisdiction. In an interview with a representative of THE ELECTRICAL WORLD Mr. Drake gave some interesting facts relating to the plans for the electrical and mechanical exhibits of the United States. The building in which these exhibits are to be displayed is not yet sufficiently advanced to show the façades, elevations, etc., but the floor plan is ready. The United States will have on the ground floor a modest space which will be used for the display of large generators, general machinery, etc. The electrical and mechanical exhibits from all countries are combined under one roof. This building will be called The Palace of Machinery and Electricity (Palais de Machinerie et Electricité). The space is divided into three sections. The ground floor is devoted to the heavy machinery; there is a space for the lighter electrical and mechanical apparatus in the gallery, and the third space, called the Salon d'Honneur, will be devoted to a retrospective exhibit which the French people desire, in this exposition closing the nineteenth century, shall be historical and shall present to the world the evolution and history of electrical and mechanical developments of this century. In that salon the United States has been awarded a reasonable space, and probably as much as any other people excepting the French themselves. Another point of interest will be in regard to the power plant, the service plant, etc. The officials estimate there will be required probably 20,000 to 25,000 horse-power, which will be devoted to lighting, motor service, transportation and other uses. This 20,000 to 25,000 horse-power will be established in two separate plants. One of the plants will be 10,000 to 12,000 horse-power, and will be located on one side of the Champs de Mars, and the other will be on the other side. The plants devoted to the French buildings will be on the side of the Avenue Bourdonnais and the other on the Avenue Suffren. The foreign section will be divided among the principal nations, Germany, Great Britain, Austria, Belgium, etc. The French will reserve half for themselves. The other portion of the plant will be on one side of the Champs de Mars and the entire Parisian section on the other side, but the two boiler plants will feed into common mains, and as far as the steam arrangements are concerned it will be the same as one battery. Provisions are made for sub-conduits to carry the water pipes, electric conductors and compressed air pipes. Steam will not be conveyed to any distance from the power plant proper, but to those exhibitors immediately adjacent to the power plant there will be given an opportunity to tap the mains coming through the main conduits. But there are few industries requiring live steam or exhaust steam, and these will be located for exhibition in the building closely adjacent to the power plant proper. Aside from that the service will not be lengthened or extended. In the court which occupies the central space in the Champs de Mars there will be a large fountain arranged in a series of cascades, for which effect they will use the condensing water of the power plant. It is rather an ingenious conception. The lighting of the buildings will not be general, but such buildings as the Electrical and Mechanical Hall or Palace, Transportation, Textile, Chemical Industries, a portion of the Agricultural Palace, the Palace of the Trocadero and the Manufactures Building will be opened at night. It may be interesting to note that electricity will not do all the illuminating at this exposition. The gardens of the Trocadero and some of the exterior features of the Trocadero will be in gas, and a very small portion of the Champs de Mars will be lighted by gas.

"The United States," Mr. Drake continued, "has received more individual concessions than any other nation, chiefly because of the importance of this country in the family of nations, and the fact that we have recently taken a new position. The Commissioner-General is mindful of the great interests of the electrical and mechanical manufacturers of this country, and of the fact that this industry has received the largest apportionment of space of any department. It practically stands at the head of the list. Machinery and electricity combined have more space than any other section in the American space. The department receives first consideration at the hands of the Commissioner-General, and has, as a military man would term it, 'the right of line.' The United States has nearly double the space of any other section. By the classification under which the exposition of 1900 will operate a new plan is provided for, whereby an exhibition of the manufactured product will be together immediately with the apparatus for manufacture and the raw product, so that the visitor will see not only the raw material in the original state, but all the processes and machinery through which it passes to become finished material. For that reason the electrical department will be of larger extent than seems on the surface the case, for there will be machines on all parts of the grounds, constructed and designed for certain industries operated in the space devoted to that particular industry or manufacture, while the space devoted exclusively to electrical goods will only carry typical machines, which cannot be exhibited in other parts of the grounds. That gives us still greater opportunity to display the progress and ingenuity with which the American designers have forged to the front."



SECTIONAL ELEVATION OF POWER PLANT AND BUILDING CONTAINING STEAM-DRIVEN EXHIBITS.

Electric Motors in Bridge Construction.

According to "The Electrical Review" of London the electric motor is being quite largely used instead of the engine in the construction of a large bridge at Budapest. The pile-driver used to sink a cofferdam, the sheet piling of which is said to consist of rolled iron girders, is motor driven and is capable of driving forty of these beams to a depth of 26 feet in twenty-four hours, the steam machine driving only about three-fourths of this number. Windlasses and centrifugal pumps are also motor driven, and the enclosed or street railway type of motor appears to be unknown, since the direct coupling of the latter was considered inadvisable, owing to moisture. The belt drives, however, serve another purpose, namely, the variation of the speed ratio, the pump speed being necessarily higher as the load increases.

Balancing the Distribution of Current in Multiple-Wound Armatures.

A practical instance of the value of the system of equalizing the output of the various sections of a parallel-wound multipolar armature, designed by Mr. B. G. Lamme, and described in these columns,* has been given by the accidental errors in connecting up some large electrolytic generators. One such machine was operated with one of the shunt exciting coils reversed for two years before the mistake was discovered, the armature cross connections passing currents which gave an armature reaction sufficient to build up the needed field. An 810-kw 180-volt 4500-ampere generator was operated continuously for three weeks with two coils reversed, very little difference in the performance being noted when the mistake was corrected. A further advantage of this system not noted in the original article is that the balancing of the field not only equalizes the distribution of the current, but equalizes the magnetic pull around the armature, which, in the case of large engine-type machines, is so great that if unbalanced it is likely to wreck some part of the apparatus. Machines with cross-connected coils can be run with the armature iron practically touching the pole pieces on one side and double the normal gap on the other, with very little tendency to cling to the near poles.

Mr. Tesla's Paper Before the Electro-Therapeutic Society.

The recent publication in an electrical journal of a paper presented before the Electro-Therapeutic Society by Mr. Tesla on "High-Frequency Oscillations for Therapeutic Applications" has elicited the following letter from Mr. Tesla to the editor of the paper making the reprint, with the request that the letter be published in the columns of THE ELECTRICAL WORLD. The letter, which is self-explanatory, is as follows:

"By publishing in your columns of Nov. 17 my recent contribution to the Electro-Therapeutic Society, you have finally succeeded—after many vain attempts made during a number of years—in causing me a serious injury. It has cost me great pains to write that paper, and I have expected to see it appear among other dignified contributions of its kind, and, I confess, the wound is deep. But you will have no opportunity for inflicting a similar one, as I propose to take better care of my papers in the future. In what manner you have secured this one in advance of other electrical periodicals, who had an equal right to the same, rests with the secretary of the society to explain.

"Your editorial comment would not concern me in the least were it not my duty to take note of it. On more than one occasion you have offended me, but in my qualities both as Christian and philosopher I have always forgiven you and have only pitied you for your errors. This time, though, your offense is graver than the previous ones, for you have dared to cast a shadow on my honor.

"No doubt you must have in your possession, from the illustrious men whom you quote, tangible proofs in support of your statement reflecting on my honesty. Being a bearer of high honors from a number of American universities, it is my duty, in view of the slur thus cast upon them, to exact from you that in your next issue you produce these, together with this letter, which, in justice to myself, I am forwarding to other electrical journals. In the absence of such proofs, which would put me in the position to seek redress elsewhere, I require that, together with the preceding, you publish instead a complete and humble apology for your insulting remark, which reflects on me as well as on those who honor me.

"On this condition I will again forgive you, but I would advise you to limit yourself in your future attacks to statements for which you are not liable to be punished by law. N. TESLA.

"NEW YORK, Nov. 18, 1898, 46 and 48 East Houston Street."

*See THE ELECTRICAL WORLD, October 29, 1898, page 440.

The Transmission Plant Les Clees-Yverdon.

BY J. LAFFARGUE.

Switzerland may be said to be the home of the hydraulic electric-power distribution plant, owing to the high cost of coal, the large number of water powers and the distribution of the manufacturing industries in small workshops scattered throughout the towns and country districts. A typical plant of this kind is that taking power from the River Orbe at the place known as Les Clees, and distributing it over a wide extent of territory in three general directions, as shown in the accompanying map, Fig. 1. The lines as there shown are tapped at many points, generally little country villages or chateaux, where they supply current to a few lights or to a small motor driving a shop manufacturing music boxes, watches or some other product peculiar to this odd little country. The description as given by the author named above in a recent issue of "L'Industrie Electrique" is translated below, with a few comments from an American point of view.

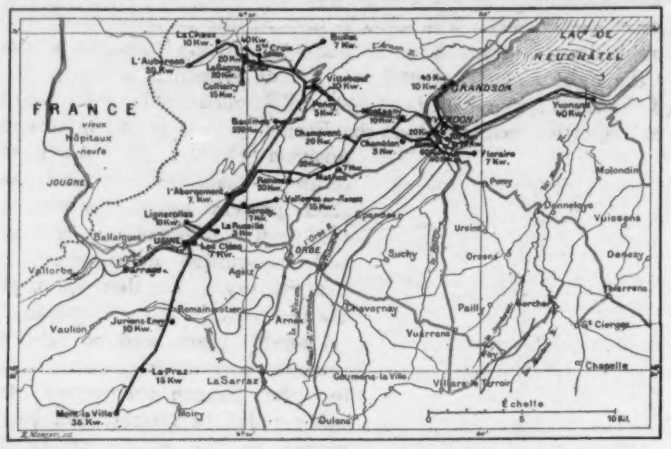


FIG. 1.—MAP SHOWING LINES AND DISTRIBUTION OF LOADS.

The installation was put up by la Société Anonyme de l'Usine des Clees à Yverdon, which obtained a concession from the Canton de Vaud in 1894 and commenced work early in 1896, the installation having been in service regularly since the first of 1897, supplying some twenty villages and towns, as shown by the map. The source of power is the fall of the River Orbe, which is a tributary of Lake Neuchatel, a masonry dam being built at the village of

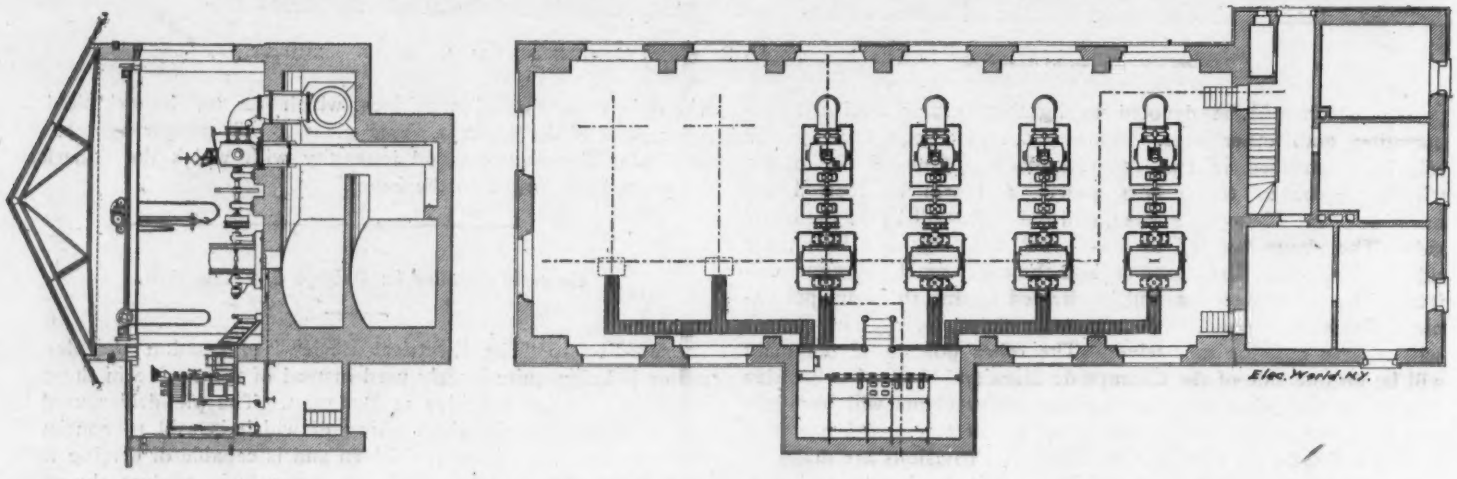


FIG. 2.—PLAN AND SECTIONAL ELEVATION OF POWER HOUSE.

Ballaigues. This is fitted with a fish ladder for the benefit of those members of the finny tribe who wish to migrate past this point. The water is taken from here in an open canal about two miles to the penstock, which is of riveted steel plate, four feet in diameter, and gives an effective head of about 150 feet. The flow obtainable is

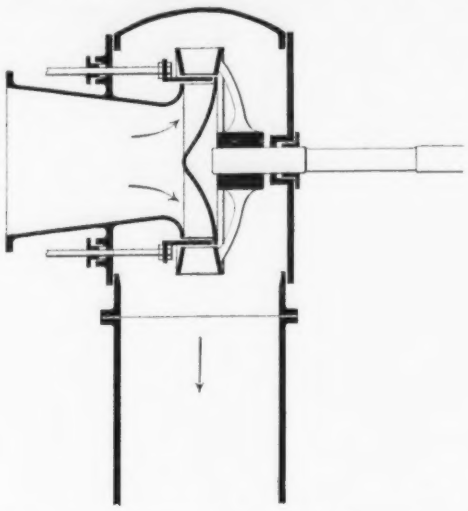


FIG. 4.—VERTICAL SECTION OF TURBINE.

about 350 cubic feet per second, giving an available output of 1800 horse-power at the turbine shafts.

The common foundation for all the machines is immediately on the right bank of the river. They stand on a pier of concrete 130 feet long, 40 feet wide and 2 feet thick. The machine room has a length of 80 feet, a width of about 33 feet and a height of 20 feet, sufficient to hold six sets of 300-hp turbines and alternators. Four groups are already installed and the fifth is under construction. The room is served by a five-ton crane. The switchboard is placed in a gallery in a special bay offset from the middle of one of the long sides of the room. This arrangement is clearly indicated in the plan and end elevation shown in Fig. 2.

The turbines, as shown in the general view, Fig. 3, are horizontal-

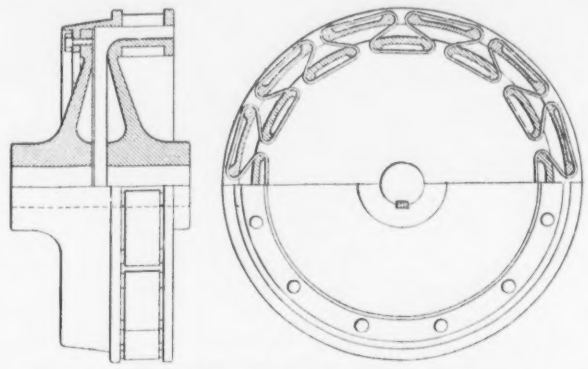


FIG. 5.—HALF SECTIONS OF FLEXIBLE COUPLING.

shaft machines made by Piccard et Pictet, their rated output being 300 horse-power each at 430 r. p. m. As appears clearly in the section, Fig. 4, the intake is axial, with outward radial flow and a vertical draft tube straight down through the floor. The runner overhangs the last bearing on the shaft, and between it and the guide chutes within it is a forged ring gate for adjusting the load. This gate is operated by a mechanical governor mounted on the top of the machine.

Next to the turbine on the shaft is a fly wheel, as appears clearly in Fig. 3, and beyond the next journal is an odd type of coupling, the construction of which is clearly shown in Fig. 5. This machine, which is known in France as the Zodel coupling, consists of two overhanging concentric crowns, with projections, around which

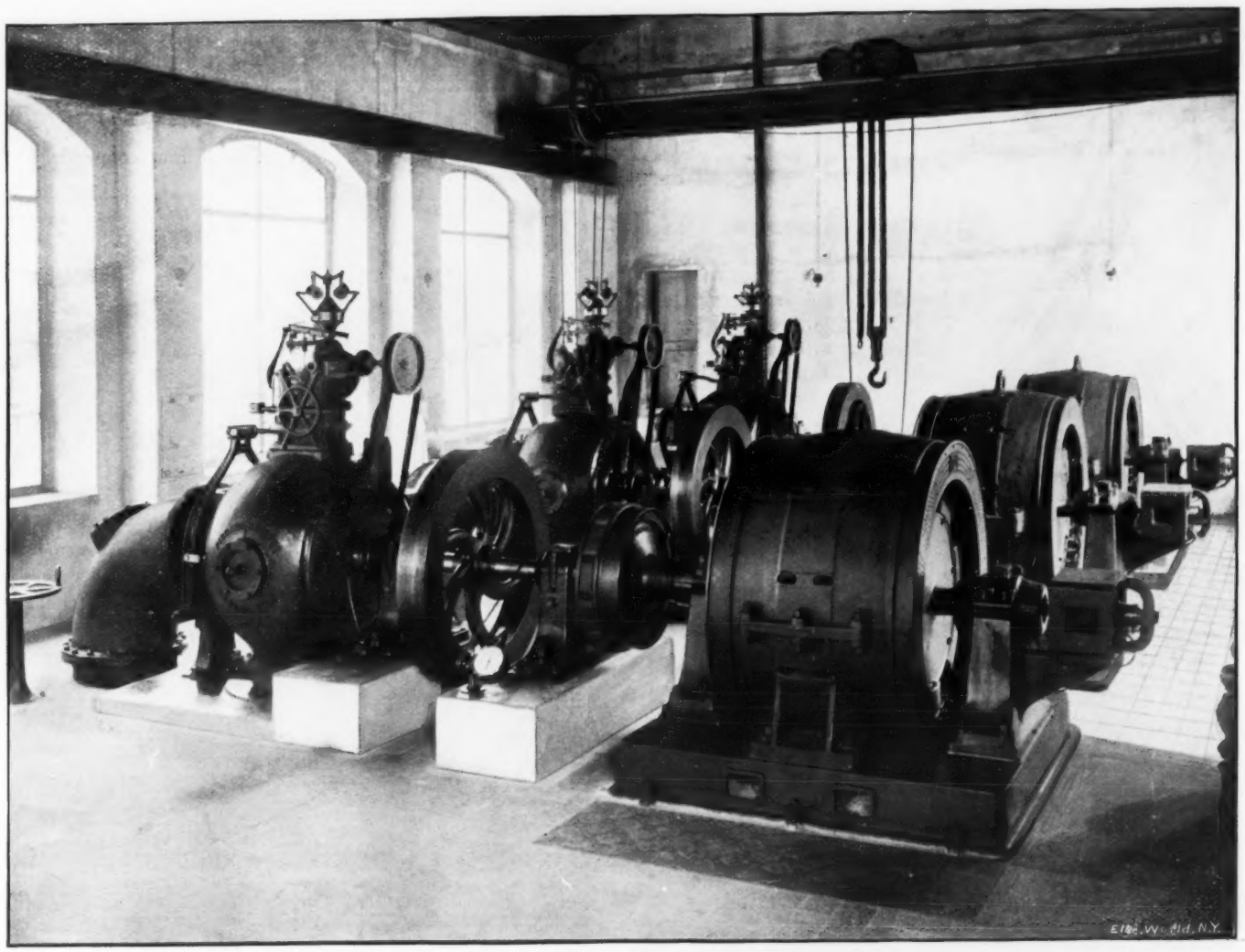


FIG. 3.—GENERAL VIEW OF TURBINES AND DYNAMOS.

is lapped a leather belt, giving flexibility, which allows a considerable variation from true alignment, and also providing electrical insulation. It will be seen that there are but two main journals, each side of the coupling, which removes the necessity for very accurate adjustment.

On each main shaft is a three-phase, 5200-volt inductor alternator, giving at normal speed a frequency of fifty cycles per second. This machine was built by la Société d'Oerlikon, and closely resembles, as may be seen by the cross-section and end elevation in Fig. 6, some American designs of inductor machines. There are two rings of laminated poles on the rotor dovetailed on bars, in turn bolted to the main casting to take up their centrifugal force, and two rings of armature laminations with six slots per pole, giving, as each ring is unipolar, one slot per pole per phase. The field exciting coil is mounted entirely outside the air gap and does not therefore come out when the rotor is removed, but requires the removal of one of the stationary armatures. The end connections of two out of every three coils are bent back exactly as in American practice. The north and south poles are axially in line with each other instead of staggered, and are magnetically connected in pairs by heavy cylindrical yokes. Each machine is fitted with a bipolar exciter coupled to the end of the shaft and supported on a bracket from the outboard pedestal.

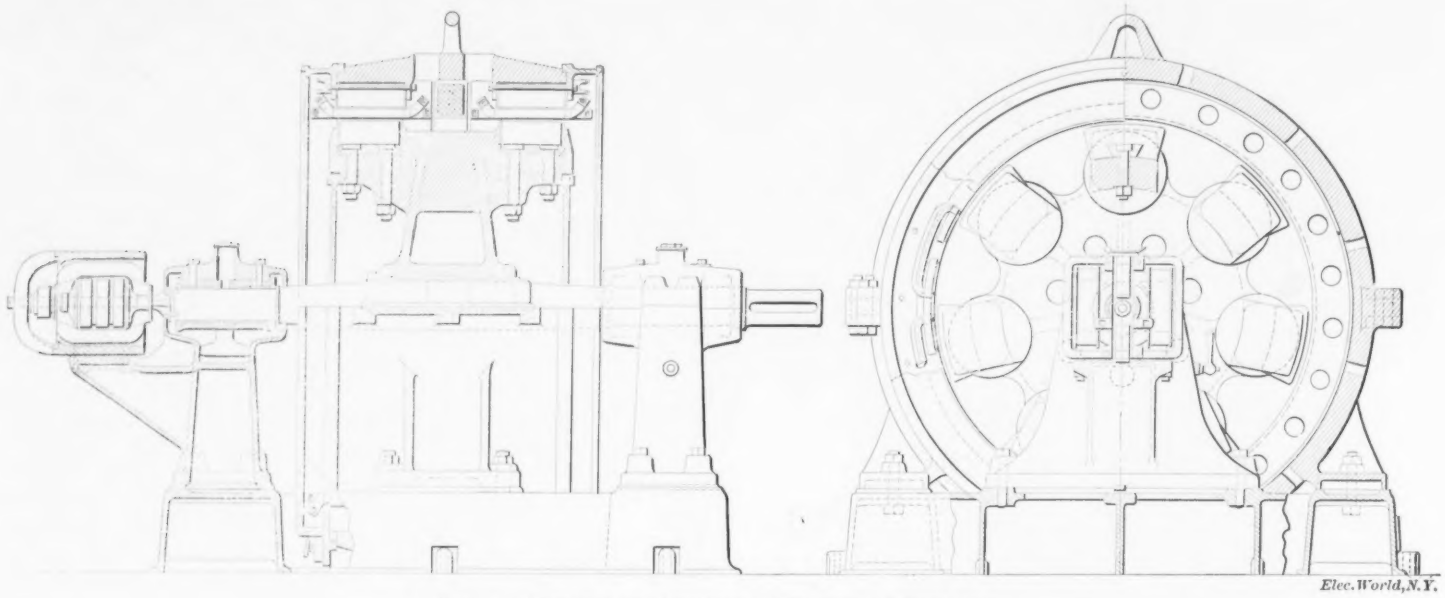


Fig. 6.—Details of Oerlikon Inductor Alternator.

The switchboard is shown in Fig. 7. Each machine is fitted with one ammeter and one voltmeter, a synchronizing indicator, fuses and a three-part rotary main switch with a pilot-wheel in front of the board and contacts behind. All the switchboard leads and bus bars are supported on double petticoat porcelain insulators similar to those used on the lines. There are two sets of main buses for the two distribution lines, each of which is fitted with a feeder panel on one side of the board. In the middle of the board is a cross-connecting switch for multipling these two systems, and totalizing ammeters in each line, with voltmeters supplied from differential transformers, which show the actual voltage at the centres of distribution. There is also installed a relay for the automatic regulation of the pressure.

The two main lines are each made up of four copper wires, one set having a diameter of 0.28 inch and the other 0.22 inch. The lines are supported on double petticoat porcelain insulators on poles spaced generally 130 feet apart, although there are on the lines two exceptionally long spans, one of about 975 feet and the

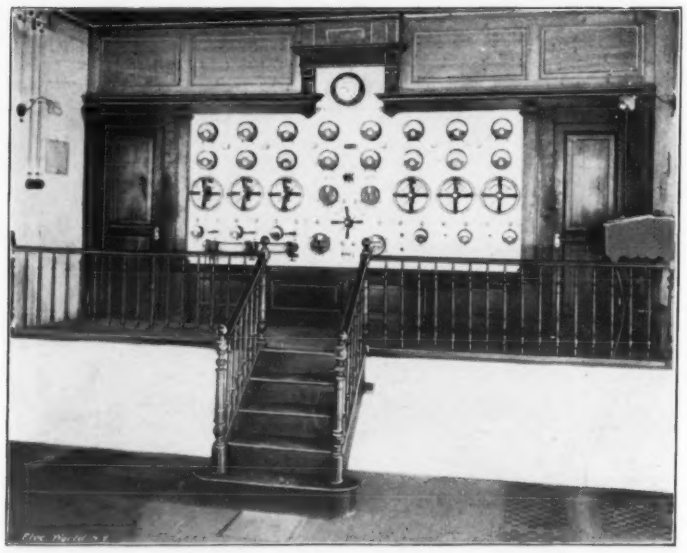


Fig. 7.—The Switchboard Gallery.

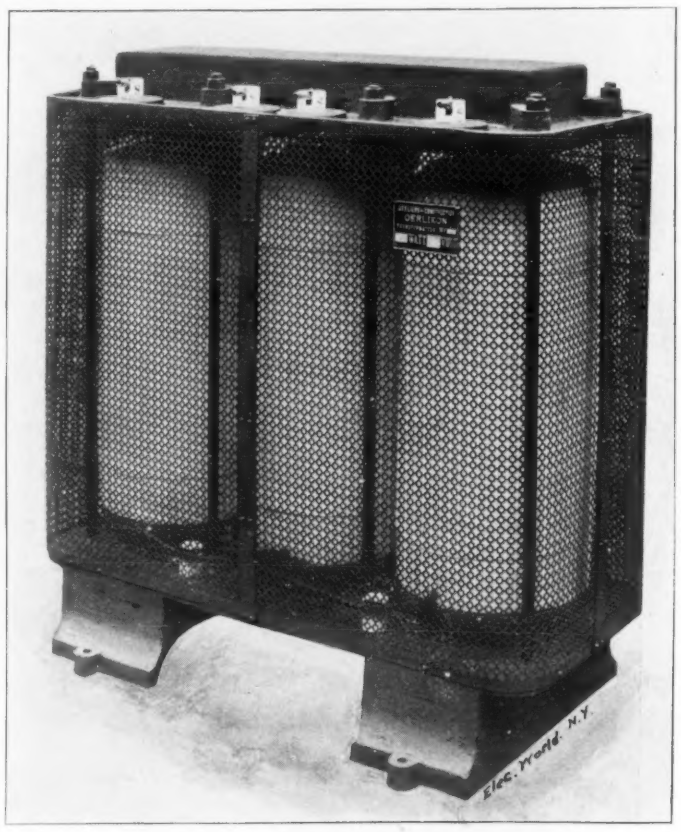


Fig. 8.—One of the Three-Phase Transformers.

other over 1000 feet in length. The total length of the primary lines is about thirty miles. One line feeds some eighteen branches and the other twelve, the map, Fig. 1, showing the amount of power demanded by each of these comparatively small loads. Each tap is taken through a switch fixed on the pole and so arranged that it can be manipulated from the ground. The transformers are

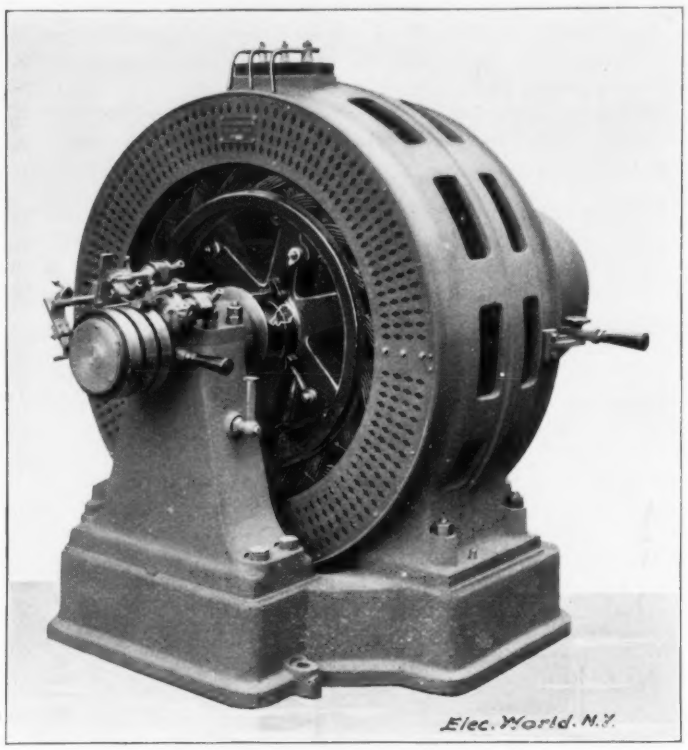


FIG. 9.—ONE END OF THE INDUCTION MOTOR, SHOWING THE SLIP RINGS.

as a rule placed in little masonry structures, isolated from other buildings and closed by iron doors, although some are placed in public buildings or on the consumer's premises.

The transformers themselves, as shown in Fig. 8, are of a three-phase core type, the three cores—one for each phase—being joined together at their ends by common laminæ so that they form a mutual common return for the lines of force. The cores are surrounded by insulating tubes on which are wound the primaries, covered again by insulating tubes with the secondaries outside. There are no ventilating passages or ducts, the transformer being air-cooled by external radiation and surrounded only by a wire screen. Both primary and secondary circuits are provided with four lightning arresters and with switches and fuses. The secondary circuits are run at 120 volts for incandescent lamps, and arc lamps are placed three in series across the same pressure. For the very small loads, but one phase is used, and it is stated that there is no trouble experienced with the regulation from lack of balance.

The lamp load is a comparatively small one, the greater part of the power being used in motors. Of these, an induction type clearly shown in Figs. 9 and 10 is that used for all above 2 horse-power, the smaller sizes being simple induction motors with plain squirrel-cage rotating secondaries. The larger motors, which were also made by la Société d'Oerlikon, are equipped with a special starting device consisting of a three-phase distributed secondary winding, apparently of the Eickemyer type, connected to three collector rings overhanging the bearing, as shown in Fig. 9. In order to get a better short circuit than could be obtained through these rings and brushes, there is fitted on the other end of the machine, shown in Fig. 10, a short-circuiting ring actuated by collars and a lever for internally short circuiting the three terminals of the secondary winding. The primary windings show clearly, all being bent back for the end connections. The smaller motors are run at the lighting pressure, others being fitted with special transformers, only one of 45 horse-power taking the full line pressure of 5000 volts.

The tariffs are considered very low, the rates per 16-cp lamp being scaled according to the amount of use and varying from about $3 per annum, if burned 400 hours, to $4.25 for 800 hours or more

The power for motor service is also sold on a sliding scale according to the amount used, varying per horse-power year from the equivalent of $50 for a one-horse motor to $15 for a thirty-horse motor, larger powers being subject to special contracts. The company has made an effort to obtain a day load by a special rate for small motors used between eight in the morning and four in the afternoon in the winter, or seven in the morning and six in the afternoon in summer. Motor power so used is measured by a meter with a time element and is charged for at the rate of about two cents per hp-hour for a small motor of one horse-power, the scale running down to a cent and a half for a six-horse motor.

The attendants required are two engineers and four assistants at the power station and a lineman in each general locality. The station runs continuously except between 9 A. M. and 2 P. M. on Sundays.

Short Cuts in Dynamo Calculations.

BY CECIL P. POOLE.

ARMATURES.

Five years ago the writer described in print a method then in use by himself, the object of which was economy in time in making preliminary calculations for the dimensions of dynamos and motors. Since then the method formerly used, with much satisfaction, has been modified so as to make it applicable to standard practice in designing, irrespective of personal preferences as to minor details. The "method" consists in basing the calculations for output upon the peripheral velocity, air-gap density and number of conductors, and in adopting at the outset fixed values for the peripheral velocity, air-gap density and proportion of armature covered by the pole pieces for each line of machines of a given type. The analysis follows:

If Φ represents all the lines of force that pass across all air gaps; Nw, the number of conductors on the armature; p, the number of distinct paths in the armature winding, and n the revolutions per second, the expression for e. m. f. will be

$$\Phi\, n \frac{Nw}{p}\, 10^{-8} = E \qquad (a)$$

Now, ignoring fringing, which is practically negligible with the

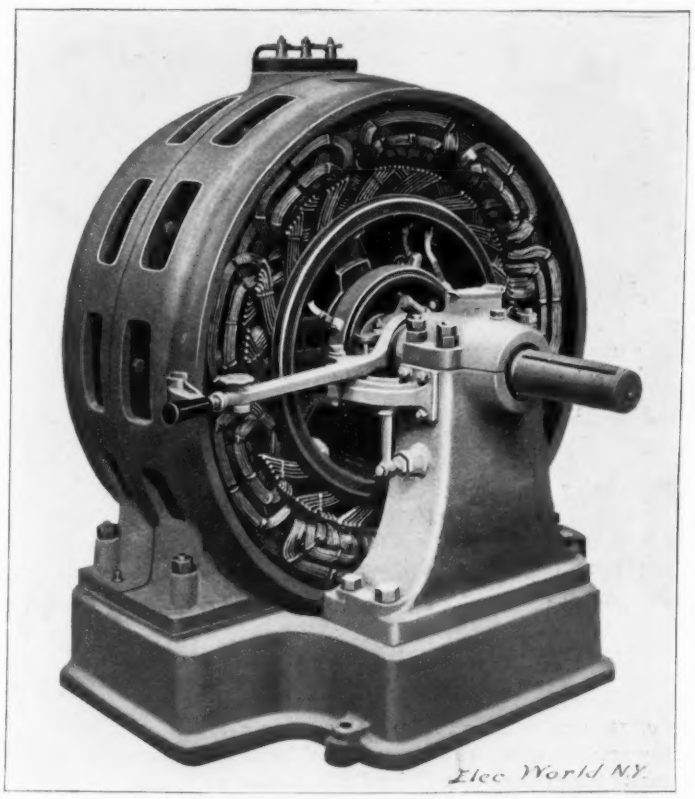


FIG. 10.—THE OTHER END OF THE MOTOR, SHOWING THE INTERNAL SHORT-CIRCUITING RING.

short air gaps commonly found, the flux Φ is equivalent to

$$\mathfrak{B}\, D\, \pi\, \alpha\, L,$$

where $\mathfrak{B}$ is the density per square inch in the air gaps, D the diameter of the armature. L its length and α the proportion of the

circumference covered by pole-faces. If dimensions be in inches and the density be reckoned in gausses then, of course, the constant 6.4516 must be included, making

$$\Phi = 6.4516\,\mathfrak{B}\,D\,\pi\,\alpha\,L\,;$$

$$\therefore\quad E = 6.4516\,\mathfrak{B}\,D\,\pi\,\alpha\,L\,n\,\frac{Nw}{p}\,10^{-8}$$

If the peripheral velocity, expressed in feet per minute, be represented by S,

$$0.2\,S = D\,\pi\,n$$

and the formula above can be changed to read

$$1.29\,S\,\mathfrak{B}\,\alpha\,L\,\frac{N\,w}{p}\,10^{-8} = E \qquad (b)$$

For those preferring to work in lines per square inch instead of gausses the equation is

$$0.2\,S\,\mathfrak{B}\,\alpha\,L\,\frac{N\,w}{p}\,10^{-8} = E \qquad (b')$$

Now, if the values of S, $\mathfrak{B}$ (or $\mathfrak{B}$) and α be determined for the whole line of machines, they need enter but once into the details of calculation, and may as well be taken out of the formula to be used for individual machines, separating the factors of the fundamental formula into two smaller ones, thus:

$$\frac{1.29\,S\,\mathfrak{B}\,\alpha\,10^{-8}}{p} = K \qquad (c)$$

or

$$\frac{0.2\,S\,\mathfrak{B}\,\alpha\,10^{-8}}{p} = K \qquad (c')$$

and

$$K\,N\,w\,L = E \qquad (d)$$

The advantages accruing from the above modification of the fundamental formula, and dividing its factors into two formulæ, are that the most tedious calculations need be made only once for an entire line *of a given type*, reducing the calculations on each machine to a nominal amount of work, and that corrections in preliminary dimensions are made very quickly. With fixed values for S, $\mathfrak{B}$ (or $\mathfrak{B}$) and α the magnetic flux is proportional to the diameter × length of the armature and the rate of revolution is inversely proportional to the diameter; the number of wires (of given size and number of layers) is also proportional to the diameter, so that under these conditions

$$E \propto D \times L \qquad (e)$$

and corrections in dimensions need only satisfy the equation

$$D\,L = D'\,L' \qquad (f)$$

or

$$L' = \sqrt{\frac{D\,L}{D'/L'}} \qquad (g)$$

or

$$D' = \sqrt{D\,L \times D'/L'} \qquad (h)$$

D' and L' representing corrected values for the diameter and length of the core, and D'/L' the ratio between the two.

The convenience of the method may be illustrated by an example. Suppose a line of machines is to be designed, ranging from 10 to 25 kilowatts in output and of tolerably low speed; the field magnet to be quadripolar and the armature slotted, or toothed, with as many brushes as there are magnet poles. An air-gap density of 6000 gausses is not excessive, nor is 0.6 for the value of α. The speed may be 2500 to 3000 feet a minute—say 2500. These values substituted in formula (c) give

$$\frac{1.29 \times 2500 \times 6000 \times 0.6\ 10^{-8}}{4} = 0.029$$

for the value of K in equation (d); $\therefore 0.029\,N\,w\,L = E$.

Placing the rate of revolutions at 750 per minute the diameter of the armature will be 12.7 inches (S being 2500). The most favorable proportion for a quadripolar machine is $D/L = 2$, which would make $L = 6.35$ inches. $N\,w$, therefore, will be $\frac{125}{.029 \times 6.35} = 676+$.

The size of the wire will be No. 10 or No. 11 if wound in single strands; taking the larger wire and winding the coils "on edge" (one wire in width and several layers deep), the slots will have to be 0.175 inch wide, each, to accommodate the wire. For preliminary work it is safe to allow three-fifths of the circumference of the armature for teeth, two-fifths for slots; on this basis a slot and a tooth will have an angular measurement, on the periphery of the armature, of $\frac{0.175}{0.4} = 0.4375$ inch, and the armature of 12.7 inches above obtained will accommodate $\frac{12.7\,\pi}{0.475} = 84$ — slots and teeth. Nw being 676, each slot should contain 8+ wires; putting 8 in a slot changes Nw to 672. With eight No. 10 wires in a slot the slots must be 1 inch deep, which will reduce the angular width of a tooth to $\frac{(12.7 - 2)\,\pi}{84} - 0.175 = 0.22518$ inch at the base. The air-gap density being 6000 gausses, the average in the teeth will be about 9100 gausses, which is a fair working density for armature teeth, though it might be made considerably higher. Having changed Nw to 672 the value of L increases to 6.42 inches.

An armature of the foregoing dimensions, etc., will give 125 volts on open circuit in a separately excited field, but no account has been taken of the loss in the winding at full load. The warm resistance of the winding described will be 0.0056 ohm, within a narrow margin either way, making the drop at 90 amperes 5.04 volts, so that to get 125 volts at the brushes the armature must be lengthened to about $\frac{130}{125} \times 6.42 = 6.68$ inches (6.7 practically), increasing the open circuit e. m. f. to 130 volts, and the resistance to 0.05712 ohm, this increase being practically negligible so far as the e. m. f. produced is concerned. The C^2R loss in the armature at 90 amperes is 462.67 watts, and as the radiating surface is about 500 square inches the heating will not be excessive.

The armature just calculated is not put forward as a specimen of ideal design; all the dimensions and basic data were assumed haphazard in the course of writing this article, without any preliminary calculation to ascertain the result, the only object being to demonstrate the convenience of the above method of making preliminary calculations. It is obvious that if the C^2R loss here obtained be considered too great by a designer, the remedy is simply to adopt a higher peripheral velocity or air-gap density, or both, thereby reducing the value of Nw, and allowing the use of larger wire as well as fewer turns. Or the slots could be made wider and deeper to take No. 9 wire, making the teeth narrower, as there is room for a material increase in density there.

FIELD MAGNETS.

The application of the above practice is not limited to armature calculations; it may be advantageously used in ascertaining the cross-sectional area of the field magnet cores, yokes and pole pieces. Having tested the iron or steel to be used, and determined the proper density at which it is to be worked, the area of any part of a simple magnetic circuit will be approximately

$$M\square = \frac{D\,\pi\,\alpha\,\mathfrak{B}\,v}{P\,\mathfrak{B}},$$

P being the number of poles, $\mathfrak{B}$ the density in the iron or steel and v the coefficient of leakage. As, for a given design of machine, all of the values excepting those of D and L may be fixed for all sizes within a reasonable range, the equation may be modified to read

$$M\square = k\,D\,L \qquad (j)$$

in which

$$k = \frac{\mathfrak{B}\,\alpha\,\pi\,v}{\mathfrak{B}'\,P} \qquad (k)$$

A convenient formula used by the writer in calculating shunt windings for constant potential machines is the following:

$$\frac{\mathrm{At}\ l_m}{V} = d^2 \qquad (m)$$

in which At is the ampere turns in the winding; l_m the mean length of one turn in inches; V, the volts at the terminals of the winding, and d^2 the area of the wire in circular mils. As this equation is correct only for a rise in temperature of 50° Fahr., a heating coefficient is required to make it universally applicable. Then it becomes

$$\frac{(0.002\,\theta + 0.9)\ \mathrm{At}\ l_m}{V} = d^2 \qquad (n)$$

θ representing the rise in temperature in Fahrenheit degrees.

For convenience and economy in time the writer has deduced the accompanying table of constants, the use of which eliminates $\frac{0.002\,\theta + 0.9}{V}$, leaving the expression, for use in connection with this table,

$$k'\ \ \mathrm{At}\ l_m = d^2 \qquad (p)$$

the value of k' for various combinations of voltage and temperature rise being found in the body of the table.

Another formula which has been found immensely convenient for getting at the necessary coil space on the field magnet cores is subjoined:

$$\sqrt{\frac{V\ \ \mathrm{At}}{\theta\,\delta\,G\,10^4}} \times d_i = \mathfrak{L} \qquad (q)$$

where $\mathfrak{L}$ represents the length along the core in inches; d_i, the di-

ameter of the wire over the insulation in mils; δ, the depth of the winding in inches; G, the girth or perimeter of the coil in inches, and θ the rise in temperature, Fahrenheit. The result cannot be absolutely accurate, because the "imbedding" of the wires of each layer between those of the layer below, which varies with each size of wire, renders it difficult to obtain, on paper, the exact value of δ. The error being from $\sqrt{.02}$ to $\sqrt{.06}$ it is not important, and the formula saves a good deal of time. Moreover, if the coefficient of shrinkage due to "imbedding" be ascertained experimentally for each size of wire, δ can be given a precise value.

TABLE GIVING VALUES OF K' IN EQUATION (F).

Temp. rise. Fah.	C.	Volts. 110	115	120	125
	10	.00854	.00817	.00783	.00752
20		.00858	.0082	.00786	.00755
25		.00368	.0083	.00796	.00764
	15	.00872	.00834	.00799	.007675
30		.00878	.0084	.00805	.0073
35		.00848	.00849	.00814	.00782
	20	.0089	.00852	.00817	.00784
40		.00898	.00859	.00823	.0079
45	25	.00908	.008687	.00832	.00799
50		.00918	.00878	.00841	.00808
	30	.00926	.00886	.00849	.00815
60		.00938	.00898	.0086	.00826
	35	.00945	.00903	.00866	.00832
70		.00958	.00916	.00878	.00843
	40	.00962	.0092	.00882	.00848
81	45	.00978	.00935	.00897	.0086
90	50	.00998	.00954	.00915	.00878

Other Voltages.

$k' = \frac{1}{2}$ the table values when V is	220	230	240	250
$k' = \frac{1}{4}$ the table values when V is	440	460	480	500
$k' = \frac{1}{8}$ the table values when V is	550	575	600	

High-Voltage Power Transmission.*

BY CHAS. F. SCOTT.

Several years ago an investigation of the conditions and requirements incident to the use of high voltages was undertaken by the Engineering Department of the Westinghouse Electric and Manufacturing Company. In this experimental investigation the size of the apparatus and the conditions of the tests were as far as practicable such as would prevail in actual work.

The transformer, the *sine qua non* of high-voltage working, received first consideration. A design suitable for large sizes was worked out and tested; then high-voltage windings were made. Attention was next directed to the line insulator.

New phenomena were liable to be presented at higher voltages and it was necessary to determine what they were, also how to meet the requirements which they impose. New forms and sizes of insulators were designed, made and tested to determine the losses which would occur and the limit at which they would break down.

The luminosity and the hissing sound emitted by the connecting wires of high voltage suggested a loss which might be an appreciable addition to that over the surface of the insulators. It was found that a very considerable loss of energy took place between the wires —a loss which at high voltages was much in excess of that across the surface of the insulators.

Mr. L. L. Nunn visited Pittsburg at this time and became much interested in this work. He was a pioneer in power transmission, having put in the first large alternating-current transmission plant in this country, namely, that at Telluride, Col., which was designed by the writer and described by him at the general meeting of this institute in 1892. It was proposed that this work be taken up conjointly by the Westinghouse company and Mr. Nunn, and prosecuted on a much enlarged scale, by operating the original motor over a high-voltage line. In a report to the vice-president and general manager of the electric company, dated April 2, 1895, the writer said: "The transformers would be arranged to give a line pressure of 10,000, which is to be increased by suitable steps to possibly 50,000 volts * * * I regard this as an excellent opportunity to make a thorough and extremely important and valuable test of high-tension working under difficult practical conditions, which our company should take up and carry out as fully as possible." Raising and lowering transformers were made and sent to Telluride, and power for the 100-hp synchronous motor was transmitted at voltages far exceeding any which had been previously used anywhere. Exceptional facilities were afforded for observing the practical operation of high-tension working under severe climatic conditions, and for making measurements. The results of the work were so assuring that the Telluride Power Transmission Company has lately installed a plant which is in commercial operation at 40,000 volts and is now making an increase in the plant. This work has been continued on experimental circuits at East Pittsburg, and some measurements have been made at Niagara.

The work which has just been briefly described was an investigation into an unknown field. It has been progressively and systematically carried out and it has determined results which were unforeseen, and which are of both theoretical interest and practical importance.

This present paper describes the more interesting and important parts of this work and gives the methods by which measurements have been made and the results which have been reached. A number of points of interest and importance are given with regard to long-distance transmission plants now in operation.

HIGH-TENSION TRANSFORMERS.

In 1891 the Westinghouse company furnished transformers for the 10,000-volt transmission to San Bernardino and Pomona. Twenty transformers were used in a set, each giving a pressure of 500 volts and the twenty in series 10,000 volts. This arrangement made the insulation within the individual coils a matter of comparative ease. The insulation between the coils of the high-tension circuit and other parts of the transformer was secured by allowing a space, which was filled with oil.

The first arrangement of transformers for giving from 30,000 to 50,000 volts was made by using a number of transformers, each giving 10,000 or 15,000 volts. The low-tension circuits of the several transformers received current from an insulating transformer in which there were a number of separate coils, each one supplying a separate raising transformer. An arrangement of this kind was used for obtaining the high voltages in the exhibit of the Westinghouse company at the World's Fair. A large transformer was designed in January, 1894. The output of 200 kilowatts was many times greater than that of any transformers which had been made by the Westinghouse company. The transformer was oil-insulated and was cooled by water flowing through a pipe immersed in the oil. This transformer was pronounced a success, and the type was adopted and has been followed ever since as a standard, except that the water-cooling is employed only on the largest size.

The transformer was then rewound for 40,000 volts, and a somewhat reduced output. It was operated at this voltage for a short time, when it was found that through an oversight the insulation between layers was insufficient. In October the high-tension coils were rewound for 60,000 volts, and the transformer is still in use after many months of varied service and a considerable period of inactivity.

The making of a single large transformer for a very high voltage naturally involved new difficulties. Above 10,000 or 20,000 volts there was an unexplored and uncertain field in the matter of insulation. Materials which were commonly used at ordinary voltages might have very different characteristics under the new conditions. Tests were made on materials before the first high-voltage transformers were made, and it has been continued. The large high-tension transformer as made to-day was not designed in a week or a month, but it has been an evolution based upon experimental tests and experience in continued operation.[1]

HIGH-TENSION INSULATORS.

After a high-voltage transformer was constructed, the insulator naturally presented itself as a fundamental factor in transmission. The requisites of an insulator for high-voltage work are, that it shall have a dielectric strength sufficient to prevent the current passing directly through the material, that its dimensions shall be large enough to prevent the passage of current over the outside of the insulator to its support, and that the resistance, both of the material and its surface, shall be sufficiently high to prevent undue loss of energy. In addition to these fundamental electrical requirements are those of a mechanical nature involving strength and con-

*A paper presented before the American Institute of Electrical Engineers, Omaha, June, 1898.

[1]See THE ELECTRICAL WORLD, March 5, 1898, page 300.

venience. These properties must of course be permanent and not liable to deterioration while in service.

Up to this time very little attention had been given to the manufacture and design of high-tension insulators. There were available for our laboratory tests the glass insulators which we had designed for the 10,000-volt transmission line at San Bernardino and Pomona, Cal.

A much larger glass insulator was made having the so-called "helmet" form, which was probably the beginning of a type which is now quite common. The large glass insulator presented mechanical difficulties in manufacture, and recourse was had to porcelain. An insulator was designed to be under-hung, the top of the insulator being supported in an inverted cup which was to be bolted to the under side of the cross-arm. From the bottom of the insulator a pin extended which was anchored in a hole in the insulator and held the wire several inches below the porcelain. The object was to place the wire below the cross-arm so that the snow which might pile up on the cross-arm would not come near the insulator. The wire, moreover, instead of being supported upon the top of the insulator, where it is in connection with an extended wet surface, would be supported from the part of the insulator which is most protected and the dryest.

An interesting evolution then began to take place in the manufacture of porcelain. There were eight or ten steps in this history, in which insulators which were presumed by the manufacturer to be satisfactory were broken down on high-voltage test. Porcelain which presented a beautiful smooth glazed surface was often found to contain internal cracks or cavities which were soon traversed by the current. In other cases bits of pebbles or other impurities were found. In still other cases the porcelain was not homogeneous

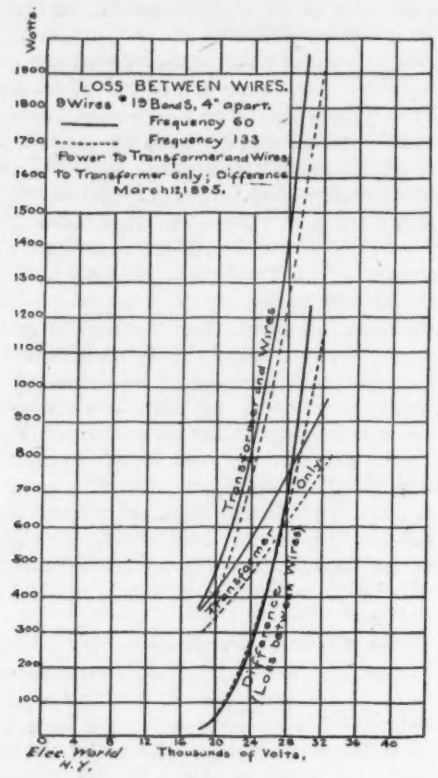


Fig. 1.

and was not compact, or the material was porous and absorbed a drop of ink almost as readily as a lump of sugar would do. The effect of this work is seen in the improved quality of material now made by certain porcelain manufacturers who benefited by this experience. It may also be remarked that some of the unpleasant experiences with porcelain insulators might have been prevented if similar preliminary tests had been made instead of employing the more expensive and inconvenient method of testing them in commercial service.

The under-hung form of porcelain insulator, however, did not prove successful nor satisfactory. The insulator was heavy and cumbersome, and no satisfactory method was devised for holding the wire. A wooden pin lacks strength, and a metal pin reduces insulation. Moreover, smaller insulators of the ordinary form were found suitable for higher pressures than was anticipated.

Some measurements were made of the losses on the Pomona insulators. Twenty-four insulators were mounted on wooden pins. A wire was run along the tops of the insulators and a second wire connected the pins. The increase produced in the reading of a wattmeter in the primary of the raising transformer when the wires were connected to the high-voltage terminals was taken as the loss

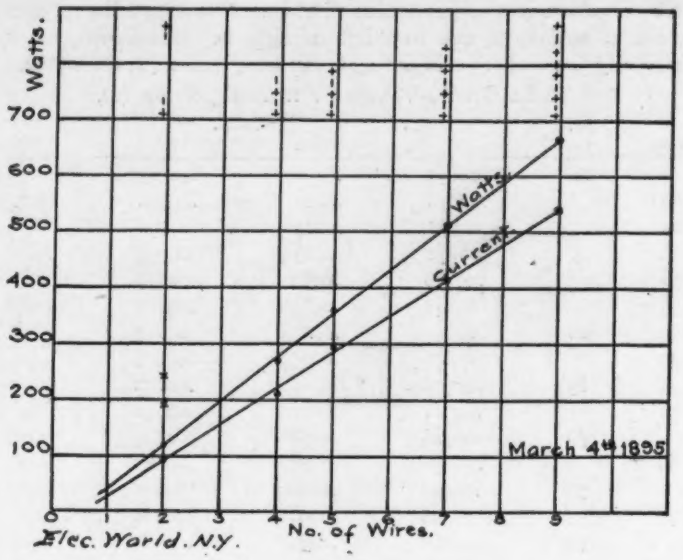


Fig. 2.

on the insulators. The loss at 25,000 volts was about two watts per insulator. This voltage between pin and wire corresponds to 50,000 volts between transmission wires.

Losses between wires.

The loss over the surface of insulators was quite small, in fact almost insignificant compared with the amount of power which would ordinarily be transmitted. The various displays of energy about high-tension wires led us to investigate and determine whether this loss was one of importance. In order to measure the loss between wires, eliminating what occurs on the insulators, it was desirable to have a considerable length of wire, to support it without insulators, and preferably to arrange the wires in such a form as to give a considerable loss. Nine wires each 60 feet long were stretched 4 inches apart in a horizontal plane and were held in place by strings several feet in length at each end. The wires were No. 19 B. & S. gauge, 0.036 inch in diameter. They could be connected in various ways, and any pair or pairs of wires could be omitted as desired.

The power supplied to the raising transformer was measured by a wattmeter placed in the primary low-tension circuit. When the load was placed on the transformer, the wattmeter reading increased, and the amount of increase was taken as the power delivered to the load. This method involves certain errors which will be pointed out further on, but on the whole it gives an approximate and fairly correct indication of the power, and is sufficient to show clearly the general form of the loss curves and a number of interesting characteristics.

The first measurements of this loss are recorded February 26, 1895. The first, third, fifth, seventh and ninth wires were connected in multiple to one terminal, and the other wires were connected to

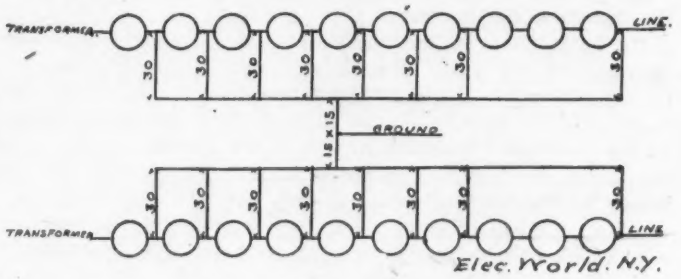


Fig. 3.

the second terminal of the raising transformer; successively increasing voltages were applied.

The wires began to give a hissing or cracking sound and in the dark began to appear luminous at a little below 20,000 volts. As the

voltage was increased the sound became more and more intense, the wires vibrated and became more and more luminous, until at the higher voltages they were surrounded by a coating of soft blue light many times the diameter of the wire. Often there were bright points along the wire, probably corresponding to bits of dust or

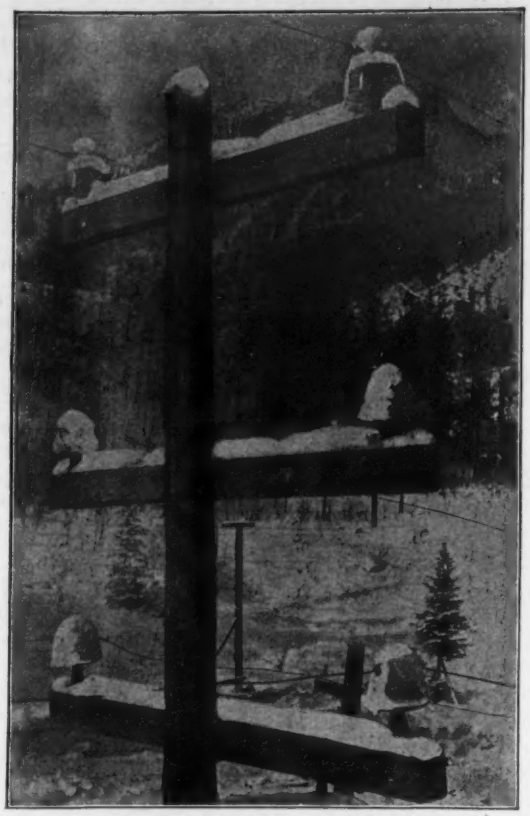


FIG. 4.—50,000 VOLTS ON LARGE GLASS INSULATORS (UPPER CROSS-ARM) AND ON PORCELAIN INSULATORS (LOWER CROSS-ARM).

rough places resembling points on the wire. The large room soon became strongly charged with ozone.

Results of measurements on all wires, alternate wires being connected together to one terminal, and the intermediate wires to the other terminal of the raising transformer, are given in the accompanying cut, Fig. 1. Three curves are given for a frequency of 60 periods per second, or 7200 alternations per minute. Two of these curves give the wattmeter readings for the different voltages, one for the transformer alone, and the other for the transformer and high-tension wires; the third curve gives the difference between the two, and therefore represents approximately the loss on the high-tension wires. Corresponding curves are given of tests made at a frequency of 133. The loss in the transformer is less at the higher frequency, but the loss on the high-tension wires is almost the same for both frequencies. These losses are very small below 18,000 volts, but increase rapidly up to 30,000 volts.

As the two sets of tests were made with dynamos having different characteristics they may not accurately represent the relative effects of the frequencies, The difference due to causes other than the frequency are, however, probably small, so that these tests are correct in showing the general relation between the loss and the pressure, and that the loss depends little if at all upon the frequency.

Tests were made with different numbers of wires. In one case the measurements were made with the arrangement described above, in which five wires were connected together and the four intermediate wires were connected to the second terminal of the raising transformer. Two wires at one end were then left off. Two of these were next omitted, leaving three connected to one terminal and two to the other. One of these was left off, leaving the first and third wires connected together, and the second and fourth also. The first and ninth wires were then connected together, also the second and eighth. As the first and second wires were well separated from the eighth and ninth, the mutual effect between them is negligible, so that the loss in this case may be considered as double that which would be obtained from the first and second wires alone. The results of this measurement are plotted in Fig. 2. The points for both loss and current fall on a straight line and indicate that each additional wire causes a definite increase.

Measurements made upon wires at greater distances show that the action is considerably less as the wires are separated. The loss is approximately the same at 28,000 volts when the wires are 4 inches apart that it is at 36,000 volts when they are 16 inches apart. The loss for a distance of 8 inches is intermediate.

Other measurements were made, but nothing of further importance was developed. It is interesting to note that within a few days of the first measurements the general characteristics of this loss were determined, namely, that the loss between wires increases rapidly after a critical voltage is reached, that the loss is practically independent of the frequency, that it is much less as the distance between wires is increased. When a loss of 1200 watts was obtained on a total length of 540 feet of wire at only 30,000 volts, the important bearing of this phenomenon upon transmission became very evident. The tests were stopped as preparations were begun for the continuation of the work at Telluride.

TRANSFORMERS AT TELLURIDE.

The original Telluride plants operated at 3000 volts. Both the generator and the synchronous motor were wound for this pressure. Two transformers were furnished for the high-voltage tests, one for raising the generator voltage for transmission and the other for lowering the voltage for the motor. The windings were connected with a number of terminals by which the high-tension voltage could be varied over a wide range up to 60,000 volts.

Coils of similar shape were placed side by side in what is known as the "parallel" form of construction. Each coil had many layers of wire and but few turns per layer, thus securing a small difference of pressure between consecutive layers. The high-tension winding was divided into four similar coils, each designed to give a maximum of 15,000 volts. The individual coils could be differently connected, either in series or in multiple. The low-tension coils were five in number and were provided with loops, by which the number of effective turns could be varied. Three low-tension coils were placed betwen two pairs of high-tension coils and the two remaining low-tension coils were placed on the two ends. Between the low-tension and high-tension coils metallic shields were placed, which were connected to the ground for protecting the low-tension circuit from danger in case of accidental contact with the high-tension circuit, and also for screening the low-tension circuit from electrostatic induction from the high-tension windings. The transformer was immersed in a case containing oil. The iron and the case of the transformer, as well as the shields between the coils, were connected to the ground.

There was also an auxiliary transformer whose primary was connected across the generator terminals, while its secondary was placed in series with the circuit to the raising transformer, thus either raising or lowering the generator e. m. f. as desired. The secondary had a number of steps so that the voltage could be varied at will.

THE TRANSMISSION LINE.

The line extends from the power station near Ames, which is a few miles from Telluride, Col., to the Gold King mill. The line passes over an exceedingly rugged country and has a total length of nearly 2¼ miles (11,720 feet). There are sixty-two poles, each carrying three cross-arms, the upper being about 26 feet from the ground. Each cross-arm carries two wires supported by insulators which are designated as follows: Large glass, small glass, porcelain. (See Figs. 4 and 5). The large glass insulator is the same as that

FIG. 5.—INSULATORS USED IN HIGH-TENSION TESTS AT TELLURIDE.

used on the circuit in the San Bernardino and Pomona plant. The total height is 5 inches and the maximum diameter 5½ inches. The bottom of the insulator stands 1¼ inches above the cross-arm. The porcelain insulator is 4 1-16 inches high and 5⅞ inches in diam-

eter. The bottom is 3 1-16 inches above the cross-arm. The small glass insulator is 3½ inches in height, 4¼ inches in diameter and stands 2¼ inches above the cross-arm. This insulator is triple petticoat; the other two insulators are double petticoat. The circuits were strung with galvanized iron wire 0.165 inches in diameter, which is No. 8 B. W. G., and about No. 6 B. & S. gauge. Later the circuit on porcelain insulators was changed to No. 6 B. & S. copper wire 0.162 inch in diameter. The measured resistance of one of the iron wire circuits was 66 25 ohms at —7° C.

THE LIGHTNING PROTECTION.

The lightning protection was laid out by Mr. A. J. Wurts, who previous to this time had spent some months at Telluride, determining the requirements for protecting the 3000-volt circuit. The protection consists of choke-coils and spark-gaps of non-arcing metal.

In each line ten choke-coils were placed. Unit arresters, each consisting of seven non-arcing metal cylinders and having six spark-gaps, were connected as is shown in Fig. 3.

RUNNING TESTS AT TELLURIDE.

The first tests were qualitative rather than quantitative. It was uncertain what phenomena might accompany the operation of a long line at high voltage, and the pressure which could be used on the insulators was a matter to be determined. The first thing was to find what would work; measurements could be made afterward. A high voltage was placed on the transmission line, sometimes transmitting no power and at other times operating the 100-hp synchronous motor. In December, 1895, the motor was operated at 25,000 to 33,000 volts for several days. In January, 1896, 45,000 volts was used continuously for over a week, and beginning with the latter part of March a continuous run of thirty-seven days was made at 50,000 volts. "Some very severe conditions of weather were encountered during this time, very high gales of wind prevailed, the air was filled with clouds of dust; part of the time the snow which fell was quite damp and during the last few days of the run there was some rain. At this voltage the wires were plainly visible at night and the characteristic hissing of high-tension currents could be heard several hundred feet. No lightning arresters had been installed up to this time and the cause of the shut-down was damage to the raising transformer, caused by lightning. Lightning arresters were installed. The lightning season commenced about June 1. During the latter part of June lightning discharges over the arresters were very frequent. At this time we were limited to a running voltage of about 34,000 volts, as there were not enough arresters to permit of increasing the voltage. No trouble whatever was had with the lightning protection. Discharges were frequently seen crossing the arresters and during two or three days in the early part of the season discharges occurred at intervals of a few seconds for several hours. Enough arresters were afterward obtained to run at 45,000 volts, but the lightning discharges were much less frequent."

Some measurements upon the line were made by determining the power given to the raising transformers when the lines were connected and when they were disconnected. These measurements showed that the loss due to the line is small below 45,000 volts, but increases rapidly when about 50,000 volts is exceeded, and reached 16.4 kilowatts at 59,000 volts. The results up to 52,000 volts are given in curve 2, Fig. 9. Curve 1 in this figure is the loss on the same circuit measured a year later by a different observer using a different method. At the maximum loss shown there is a difference of only 8 or 9 per cent. in e. m. f. for the same loss on the two curves.

The record of the operation of this line at 50,000 volts for over a month is of very great interest, as it is a practical demonstration of the feasibility of operating a line at 50,000 volts, a pressure four or five times as great as any which had been in general commercial use. Mr. V. G. Converse had been up to this time closely associated with this work. He had much to do with the design and construction of the high-tension transformers and insulators, tests upon losses in lines made at the Pittsburg laboratory and the tests at Telluride.

MEASUREMENTS AT TELLURIDE.

The work at Telluride was then taken up by Mr. R. D. Mershon. The facilities for experimental work were increased and instruments were provided for carrying on the tests. Mr. Mershon found peculiar difficulties in making exact measurements of the power to the circuit. A wattmeter in the low-tension circuit of the raising transformer led to errors under the conditions which prevailed. Some very able and painstaking work was displayed in detecting the error and overcoming it with the facilities at hand—and the facilities were none too plenty in the heart of the Rocky Mountains for making measurements which would tax the resources of almost any laboratory. The apparatus used introduced a disturbing influence in the circuit, which, however, could be measured and eliminated. On the other hand, a wattmeter for measuring power on a high-tension circuit must accommodate a very high voltage and a very small current. As the charging current to an open line is usually very large in proportion to the loss current, the error of the instrument is very sensitive to slight variations of phase in the shunt current. (A description of the instruments and the methods used is given in an extract from the report of Mr. Mershon at the end of the author's paper.) The result of the measurements and the conclusions are given partly by extracts from Mr. Mershon's report, and partly in abstract.

RESULTS OF MEASUREMENTS.

"The results of measurements taken are embodied in curves.

"In every case the measurements were taken upon an open-circuited line—in no case upon a line which was transmitting power. The line losses obtained are therefore a combination of those occurring between the line wires and the very small $I^2 R$ loss in the wire itself due to the charging current of the line.

"Measurements taken with the Weston wattmeter include the loss in the high-tension coil of the power transformer due to the currents applied to the line. This loss is in general small and in the following curves corrections have not been made for it. Curves taken with the Thomson wattmeter require no such correction.

"There is an additional correction which may be made in the case of those curves whose voltages were obtained from the raising transformer. This correction arises from the fact that the action of the capacity current taken by the line, in connection with the series reactance of the transformer supplying it, is such as to make the voltage impressed upon the line somewhat greater than that obtained by the ratio of the transformer winding. The measurements taken to determine the amount of the error in voltage show it to be small.

"There were two generators used. One was that regularly running and supplying power to the power circuits of the Telluride Power Transmission Company. It is a 600-kw, 22-pole, quarter-phase machine, delivering 500 volts at a frequency of 60, or 7200 alternations per minute. Its armature is of the slotted type and is wound with copper bars. In the notes this generator is designated as 'Slotted Armature.'

"The other generator is one whose field is that of the 100-kw toothed armature machine, originally sent out as a part of the first Gold King transmission plant. It has twelve poles and as originally run operated at 3000 volts and 10,000 alternations. There are two armatures for this machine—a surface-wound armature, designated as 'Smooth Armature,' and a toothed armature, designated as 'Toothed Armature.'"

A set of measurements was made for comparing the loss on the three circuits supplied respectively with large glass, small glass and porcelain insulators. The curves are very nearly identical and correspond very closely with the right-hand curve in Fig. 6. "There was a heavy wet snow on the ground and the cross-arms at the generating station and more or less snow all along the line, that at the further end being dryer than at the generating station. There was more or less snow falling during the measurements, and this accounts for a wide variation of the points taken at the high voltages, as falling snow renders the wattmeter reading very unsteady, the unsteadiness being such as one might expect if from time to time there was a discharge between the wires. This unsteadiness does not seem to be as great in the case of falling rain as in the case of falling snow."

A series of measurements was made to determine the connection between the loss and the distance between wires. "As at that time it had not been fully demonstrated that the loss was not affected by weather conditions except there was precipitation, changes in distance between wires were made upon one circuit, while the distance between wires on another circuit was maintained always the same, and the latter was used as a reference circuit when a change in loss was observed."

The several curves have been plotted together, due correction being made for the slight difference in the loss in the reference circuit, which probably resulted from slight differences in the precipitation when the curves were taken. The distance between the wires in the several tests was 15, 22, 35 and 52 inches respectively. The results are shown in Fig. 6. It will be noted that the loss is much greater when the wires are close together and that the curve begins to ascend at a lower voltage.

The loss curves in Fig. 7 were taken on one of the circuits, first with the Weston wattmeter and then with the Thomson wattmeter. The Weston wattmeter was not in circuit when the measurements with the Thomson wattmeter were taken. As an additional check, the readings were taken on each of the wattmeters of the loss occurring in the shunt resistance; of the Thomson wattmeter the results were in practical agreement with each other and with those obtained by calculation. The discrepancy in the results obtained on the two instruments when measuring line loss will be referred to later.

A set of comparative readings was taken on one of the circuits and on a dummy circuit, identical with the main circuit, as regards kind and number of insulators and the size of wire, but only 60 instead of 11,720 feet in length. The results show that the loss on the two circuits is practically identical up to about 50,000 volts, which is the part of the curve below the bend. The losses agree closely with those shown in Fig. 6. At higher voltages the loss on the dummy circuit increased slightly, indicating that the loss was of

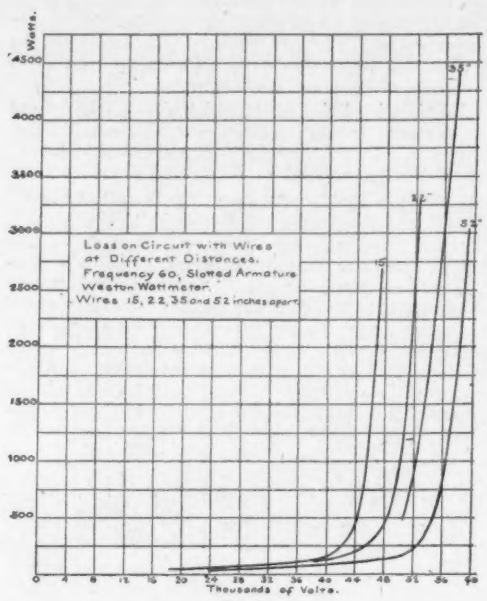

Watts.
Loss on Circuit with Wires at Different Distances.
Frequency 60, Slotted Armature
Weston Wattmeter.
Wires 15, 22, 35 and 52 inches apart.
Thousands of Volts.

FIG 6

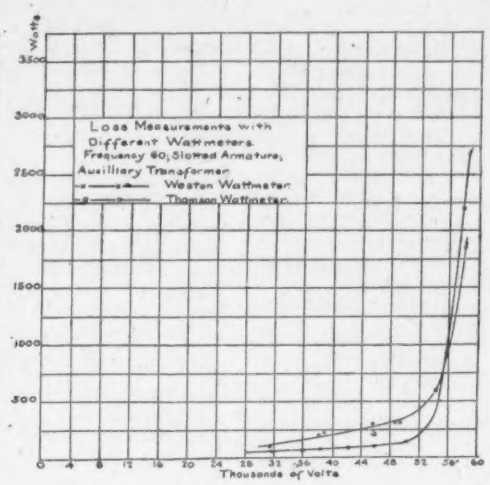


FIG. 7.

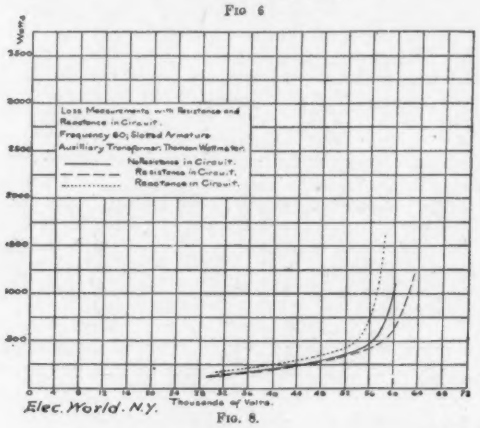

Loss Measurements with Resistance and Reactance in Circuit.
Frequency 60, Slotted Armature
Auxiliary Transformer, Thomson Wattmeter.
No Resistance or Reactance in Circuit.
Resistance in Circuit.
Reactance in Circuit.
Thousands of Volts.
Elec. World. N.Y.

FIG. 8.

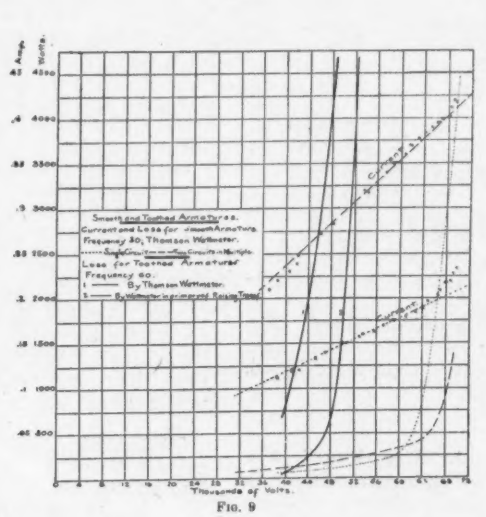


FIG. 9

the same nature as that at a lower voltage. The agreement of the loss on the two lines at low voltage (*i. e.*, below the bend in the loss curve) indicates that this loss was over the insulators. The great increase in loss on the long line at high voltage indicates that the loss was due, not to the insulator, but to the line.

Measurements were made with resistance between the generator and the raising transformer, then with reactance and then with neither resistance nor reactance. The results are shown in Fig. 8, and indicate a different condition, depending upon the character of the circuit supplying the current. It was presumed that this difference arose from a modification of wave form of the e. m. f. applied to the line.

Measurements were made upon the wave form and the corresponding losses when different generators were used and different circuits were connected. In one test an armature giving nearly a sine wave was used which delivered current at 30 cycles. Measurements were made upon one circuit only, and then upon two circuits in multiple. The current and the loss are both given in Fig. 9.

(To be continued.)

Electrical Fakirs and the Lay Press.

A popular conception of the science of electricity is that a dark and awful mystery enshrouds it, and that those who practice it are wizards endowed with unearthly powers. It has consequently been a fruitful field for fakirs, a sort of happy hunting ground for those who "live by their wits." The sins of falsehood committed in its name have been legion and continue to be propagated, especially by newspapers which should know better, at a fearful rate. It appears that the art of exploiting sensational falsehoods has of late grown to the proportions of a regular business, and that actually a number of "agencies" for the manufacture and sale of lurid literature for the Sunday newspapers are in existence.

The method used is for the sagacious employee of one of these bureaus of prevarication to invent and imagine the tale and sketch it in the rough, leaving out names and places. Then his predatory instincts come into play and he sallies forth to find an accomplice who will "stand for" the principal character. This personage is a degree worse than the writer of the story, because the latter often has the excuse of a living which must be made, while the former is only anxious to play the part of the jackdaw in the fable. Too frequently the accomplice who "stands for" the "fake" is an alleged electrician, the most of such stories as find publicity being about marvelous advances in the electrical line.

There have been some recent yarns duly set forth with pictures and other attractive embellishments that are strongly suggestive of the methods of the news agency. It is deeply to be regretted that the competition of newspapers as to which can publish the most startling sensation and the gullibility of the public have resulted in the common appearance of such matters. The silliness of some of the journalistic "fakes" is almost beyond belief. Schemes to photograph thought (with reproductions of the photographs), to drive all the machinery in New York from the power of the Coney Island surf, etc., are beginning to pall upon the sated taste of the public. Before long we may hear of a revival of the labors of Dean Swift's philosophers, who were engaged many years ago in making sunbeams from cucumbers.

The Brush Multi-Circuit Arc Machine.

Patents No. 613,880, 613,881 and 613,882, issued November 8, 1898, to Mr. C. M. Green and assigned to the General Electric Company, cover the principles and details of the multi-circuit arrangement of the Brush constant-current arc machines. This arrangement, which is now well known to central-station men, consists of a division of the external load into two or more parts, these parts being separately connected in between the several sections of the commutator. The arrangement is such that all parts of the load and of the machine windings are in series, the circuit being first through one section of the armature windings, then out and through one section of the load, back and through the next section of the armature windings, then through the next section of the load, etc., according to the number of circuits, and finally back to the starting point. Thus, in a 160-light, four-circuit machine, for example, the potential rises about 2000 volts on one section of the machine, falls again to its original value in one section of the load and rises again, so that the maximum difference of potential between any two points of the circuit is only 2000 volts, instead of the 8000 that would be obtained without this arrangement. This gives a great reduction of the breaking-down stress on the insulation under ordinary circumstances, but gives practically the full voltage of the machine across any accidental opening in the circuit.

DIGEST
OF
CURRENT ELECTRICAL LITERATURE
AMERICAN AND FOREIGN
By Carl Hering

Dynamos, Motors and Transformers.

ELECTRIC GENERATORS. Parshall and Hobart. Lond. "Engineering," Nov. 4.—In this continuation of their serial (see "Digest") they continue the discussion of commutation in direct-current dynamos. They point out the importance of the inductance of the short-circuited coil in the design of the machine; the constants concerning this inductance are best determined by actual measurements; in practice a good average expression is that one ampere turn will give a field of 20 C. G. S. lines per inch of length of armature coil; it is convenient to assume this as a basis for working out a design, and after the design is completed the figures are corrected according to the dimensions of the final design. Several tests are described, the results of which have a direct bearing on the value of the constants, and by a study of these results the most desirable proportions of the armature slot can be determined, which will bring the inductance down to, or even below, this figure; they refer to the coils in which the current is being commutated, and the tests described show how to measure this inductance; five such tests, with the tables of results, are described. They give as the practical definition of inductance the following: "A coil has an inductance of one henry when it is situated in a medium of such permeability, and is so dimensioned that a current of 1 ampere sets up a magnetic flux of such a magnitude that the product of the number of lines linked with the coil by the number of turns in the coil is equal to 100,000,000." The inductance is furthermore proportional to the square of the number of turns in the coil.

CONTINUOUS-CURRENT DYNAMOS AND MOTORS. Guilbert. "L'Eclairage Elec.," Nov. 5.—Brief, illustrated descriptions taken from patent specifications.

PREDETERMINATION OF ROTARY PHASE MOTOR DIAGRAMS. Rothert. "Elek. Zeit.," Nov. 3.—An elaboration of this theory and a deduction from it of a simple method for calculating the complete diagram.

ROTARY FIELD MOTORS. Hanappe. "L'Eclairage Elec.," Oct. 29.—Another installment of his long mathematical article. He discusses the elementary graphical theory of non-synchronous polyphase motors in which magnetic dispersion and Foucault current and hysteresis losses are not considered.

Lights and Lighting.

ELECTRIC LIGHTING APPLIED TO ARCHITECTURE. Ekin. "El'ty," Nov. 16.—A reprint of the paper read before an architectural association in which he discusses internal lighting and the manner in which the current should be conveyed to the lights. He limits himself to the incandescent lights. Every room to be lighted should be examined from three different points of view, the purpose for which it is to be used, the decorations, furniture and general surroundings, and the cost of the proposed lighting.

LUMINOUS FOUNTAIN. Lohman. "Jour. of El'ty," Oct.—A detailed, illustrated description of the electrical fountains in the Schilling gardens in Oakland, Cal., which he, in part, designed. The fountain is only 14 feet in diameter.

Power.

ELECTRICITY ON WAR SHIPS.—Lond. "Elec. Rev.," Nov. 4.—Extracts from the U. S. "Army and Navy Register," containing reports on the use of electricity on board the Brooklyn, showing that it was eminently satisfactory in the recent action off Santiago.

ELECTRIC CAPSTANS.—Lond. "Engineering," Nov. 4.—The conclusion of the illustrated description of those used by the Northern Railway of France.

ELECTRICALLY OPERATED DRAWBRIDGE. Kidde. "Stevens Indicator," reprinted in "El'ty," Nov. 16.—A reprint of a short article describing the 40-ton drawbridge over the Passaic River at Newark, which is said to be the largest electrically operated drawbridge constructed. It is operated with a 500-volt, direct-current, and opens or closes in thirty seconds. It has been in successful operation for the past five months.

CONTROLLING MOTORS FROM A DISTANCE.—"Elec. Rev.," Nov. 16.—A reprint at considerable length, with the illustration, of Tesla's recent patent for controlling from a distant point, the operation of the propelling engines, starting apparatus, or other mechanism carried by a moving object, such as a vessel, and for bringing into action at any desired time any device carried by it.

LONG-DISTANCE TRANSMISSION.—"El'ty," Nov. 9.—A note calling attention to the water-power plant for supplying power for street cars, lighting and factories in the city of Victoria, B. C. The head of water is 1000 feet, the distance of transmission is 12 miles, and the current is carried by six copper wires; (what the system is is not stated). The pipe line is 6700 feet in length.

Traction.

HEAVY RAILROAD WORK IN ITALY.—"Elec. Tech.," Oct. 15; abstracted briefly from "Elettricita."—A note stating that on the road from Milan to Monza only accumulator cars will be used, whereas on the road Lecco-Sondrio the high-tension, three-phase current system will be used, the current being generated by water power. According to the "Elek. Zeit.," the work on the line from Milan to Monza is to begin at once.

HEILMANN LOCOMOTIVE.—"Cosmos," Oct. 29.—A note stating that the locomotive is not in service, but that the official reports continue to pronounce the experiment a success. The experiments showed that the vibrations were reduced to almost nothing. It is announced that the locomotive will again be put into service.

ELECTRIC RAILROADS IN HUNGARY.—"Zeit. fuer Elek.," Oct. 23.—Brief extracts from statistics for the end of the year 1897. The total length of street railways was 187.5 km, of which 103.8 were electrical and consisted of eight railways.

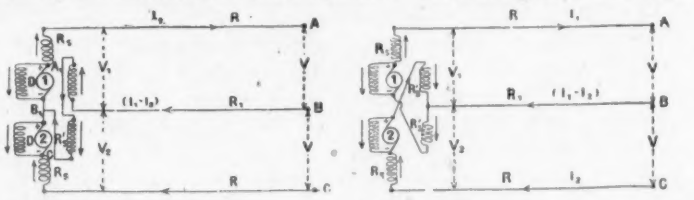
SURFACE-CONTACT SYSTEM. Anderson. Lond. "Elec." and "Elec. Eng.," and without illustrations in Lond. "Elec. Rev.," Nov. 4.—A brief, illustrated description of this system, one of the chief features of which is that the surface contact plugs are not fixed, but have a 4-inch vertical motion; when no car is over them they are flush with the pavement; when a car passes they are automatically raised 4 inches, so as to come in contact with the collector bar, and simultaneously with this motion they are made alive. The cost of the boxes, according to the inventor, is $6000 per mile. The apparatus is essentially a mechanical one, as the studs are raised and lowered mechanically by the car itself through the medium of wires connecting the boxes. The description is fuller in the "Elec. Rev." and "Elec. Eng.," and the illustrations are better in the latter.

ELECTRIC CANAL HAULAGE. Galliot. Lond. "Elec.," Nov. 4.—A short description of the working of his system at Pouilly, in France, which was referred to unfavorably in the recent paper by Allen. Twenty-six kw have been in operation since the beginning of this year; the system consists of tricycles running on the towpaths and fitted with electric motors, the current being obtained from overhead wires; there are two generating stations of 200 horse-power each. Notwithstanding the apparent low efficiency of a tricycle on a common tow-path, the power available on the tow rope averages 60 per cent. of that at the brushes of the motor. The motors are 6 horse-power, which is necessary for 300-ton barges at a speed of 1.5 miles per hour. The assumption of Allen that 2 horse-power could haul 100 tons at 2.5 miles per hour does not agree with Galliot's experience, in which a speed of only 1.5 miles an hour was reached under these conditions. As it has been successful, the lines are to be extended over 84 km, 30 of which will soon be completed. The charge is 0.106 cents per ton mile, empty barges being hauled gratis; although not cheaper than horse traction, the speed and regularity are superior; it is claimed that the profit cannot fail to be very large.

THOMPSON-WALKER SYSTEM.—"El'ty," Nov. 16.—A reprint without the illustration of the article noticed in the "Digest" last week.

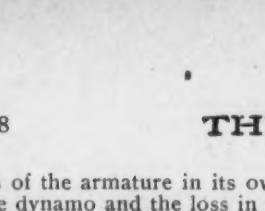
Installations, Systems and Appliances.

REGULATION OF VOLTAGE IN A THREE-WIRE SYSTEM. Del Proposto. "L'Eclairage Elec.," Nov. 5.—Descriptions, accompanied by brief theories, of various methods of automatic regulation of the voltage, for very rapid changes in the currents in the two branches. Such a regulator should maintain the voltage between the outers constant, and should divide it equally between the two branches; any system requiring the movement of switches would be too slow; in the methods which he described it is done by the excitation of the machines. One arrangement is shown



in the first figure, in which it will be seen that each of the two dynamos has its own shunt and series windings, and besides this each has an auxiliary field coil through which the current in the neutral wire flows. The shunt winding produces the difference of potential on open circuit; the series or compound winding com-

pensates for the loss of the armature in its own winding—that due to the reaction in the dynamo and the loss in the outside wires; the supplementary winding adds its action to these two to that machine which delivers more current, and deducts it from the excitation of the machine giving less current; this winding should raise or lower the voltage of the machine by an amount equal to the product of the neutral wire current by the sum of the resistances of the neutral wire and twice the resistance of each coil; that is, it should compensate for the loss in the whole neutral wire circuit, including the coils. The second solution is shown in the second figure, and will explain itself; the supplementary coils, in this case, oppose their action to the effect of the other two windings. This method is not as good as the first, as the total amount of excitation is considerably greater. For determining the excitation of each machine in the first case proceed as follows: Calculate the total ampere turns (1) for the normal current and the required voltage at the extremities of the total resistance, including the one outer, the neutral, the series coil and one auxiliary coil; then the ampere turns (2) for the normal current, and the same difference of potential at the ends of the resistance of one outer and the series coil; and finally the ampere turns (3) for the voltage on open circuit; then the ampere turns (1)—(2) should be generated by the supplementary series coil, the ampere turns (1)—(2)—(3) by the series winding, and the rest by the shunt winding. Such machines can serve only for the feeder for which they have been calculated, and no other machines can be connected in parallel to the same feeder. With auxiliary terminals, however, the series excitation can be divided into two parts, all of it being used when only one set of machines is in use, while part of it is cut out when two groups are used in parallel; a similar means can be adopted when a pair of machines is used with feeders of different resistances; they will operate right when the current in the two sets of feeders is divided proportionately to their cross-section, which in general is not the case; in every case, however, the arrangement is better than the usual one. He then discusses similar arrangements for equalizers, which are used when the neutral wire does not go back to the original dynamos, but only to the local equalizer, and consist of two dynamos coupled to the same shaft, one acting as a motor and the other as a dynamo, according to the neutral wire current. In its simple form it cannot equalize the voltages perfectly; moreover, the brushes must always be at the neutral point, because the machines act sometimes as a motor and sometimes as a dynamo; the equalization will be less perfect as the neutral current and the armature resistance are greater. The e. m. f. of the one acting as dynamo should be increased and that of the one acting as a motor should be diminished; this can be accomplished by exchanging the excitations of the two machines—that is, exciting the shunt winding of each from the armature of the other; a practically perfect regulation can thus be ob-



tained by proper proportioning. Let *A B O* in the adjoining figure be the curve showing the relation between the e. m. f. induced *e*, and the difference of potential *V* applied to the armatures; then the conditions are that the portion *A B* of the curve makes an angle of 26.5°, the tangent of which is 0.5; this condition can be satisfied by proper choice of the sections and materials used, the resistance of the magnetic circuit remaining within the ordinary limits. (Siemens and Halske, who patented the next two methods described, claim that this one will not accomplish the object.) In the next two methods described the two shunt windings are in series between the outers; two supplementary coils are added similarly to the two methods above illustrated for the original dynamos; there are no series coils in series with the outers. He shows how these windings should be proportioned. The first of these three methods is the simplest, and gives the best results, but requires careful proportioning with respect to the magnetic curve, which is not the case with the two latter, the last one of which is preferable to the other. In all three two totally separate machines (except that the armatures are mechanically coupled) are required. He then discusses at some length the effect of the speeds of the armatures in the equalizers, both analytically and graphically. The variation is less than for two motors connected in series to a constant difference of potential; neither the maximum nor the minimum speed will be at no load.

STOPPAGE AT BRIGHTON.—Lond. "Elec.," Nov. 4.—Referring to the stoppage at that station noticed in the "Digest" last week, Tapper states that the substitution of maximum cut-outs for minimum cut-outs would not overcome the difficulty, for if the armature was short-circuited the results would be precisely the same. Undoubtedly the correct explanation is that the combined effect of decreased speed and armature reaction reduced the dynamo fields to zero; this is a perfectly well-known result on the short-circuiting of a shunt dynamo. The action of the minimum cut-outs was the result, and not the cause, of the cessation of current. A serious danger would be introduced by omitting the minimum cut-outs; if a bad short-circuit occurs somewhere in the network the engineer is in an extremely awkward predicament and cannot re-start. He concludes that the use of non-return cut-outs and separate excitation are the only possible remedies, are absolutely essential, and afford complete security. Philip suggests that the cause may have been a break in the shunt circuit of the damaged dynamo.

PRICE OF ELECTRICAL ENERGY IN NEW YORK.—Lond. "Elec. Rev.," Nov. 4.—An editorial discussion of the recent reduction in price of the Edison Company in New York, criticising the system and showing that the charges are high. It is admitted that in tramway enterprise England is behind America, but in the distribution of cheap electricity the English have nothing to learn from New York.

BATTERY BOOSTER.—Lond. "Elec. Eng.," Nov. 4.—Several answers to the question whether a 40-volt shunt-wound dynamo is the best booster to use for raising the voltage of a 100-volt circuit for charging batteries; also whether it is not likely that the booster may reverse.

CONTROLLING APPARATUS IN CENTRAL STATIONS. Dunning. Lond. "Elec. Eng.," Nov. 4; reprinted in "El'ty," N. Y., Nov. 16.—A short article giving practical hints concerning switchboards and other controlling apparatus.

NURNBERG. Scholtas. "Elek. Zeit.," Nov. 3.—The beginning of a very long, well-illustrated description of this station, in which the simple alternating current is used. The station contains four direct-connected dynamos of 500 horse-power each and one of 1000.

ARSENAL PLANT.—Lond. "Elec. Rev.," Nov. 4.—A brief, illustrated description of the plant at the Woolwich arsenal. It consists of a single direct-connected, continuous-current dynamo, which is said to be one of the largest in the United Kingdom; it has a nominal output of 375 kw at 330 volts, and a speed of 120; the total weight of the dynamo is 40 tons.

DRIVING EXCITERS.—"Jour. of El'ty," Oct.—An editorial discussing the best means of driving the exciters in a water-power plant. If driven from the alternator its speed will fall when that of the alternator falls, and this is not preventable; if driven direct by a small water-wheel there is a liability of the wheel-nozzle becoming choked, but this is preventable. The inference is to use the latter method.

POSSIBILITIES WITH ELECTRIC LIGHTING PLANTS. Poole. "Jour. of El'ty," Oct.—A reprint of a paper read before a Western gas association, and intended for managers of gas plants who are "saddled with an electric light plant" which is not paying; he endeavors to show how such plants may be made profitable.

Wires, Wiring and Conduits.

RULES AND REGULATIONS.—"L'Eclairage Elec.," Oct. 29, and "L'Elec.," Nov. 5.—A reprint of the official instructions accompanying the law concerning electrical conductors in France. Under high-tension installations are included those using continuous currents of more than 600 volts or alternating currents of more than 120 effective volts as a maximum; low-tension installations are those using currents below these voltages.

ELECTROLIERS.—Lond. "Elec. Rev.," Nov. 4.—Illustrations of some new artistic fittings.

Electro-Physics and Magnetism.

EFFECT OF SOFT IRON ON HIGH-FREQUENCY CURRENTS. Pellat. "Comptes Rendus," 126, p. 731; abstracted in "Science Abstracts," Oct.—A certain negative experiment might appear to show that iron is not magnetized in the magnetic field alternating with high frequency, but another experiment shows that the iron is magnetized and that its magnetization may have a considerable influence on certain phenomena. His experiments show that the presence of even a small quantity of iron in the axes of a coil prohibits the use of a certain classical formula for obtaining the value of the oscillating current.

DISTRIBUTION OF MAGNETIC INDUCTION IN STRAIGHT IRON RODS. Gill. "Phil. Mag.," Nov.—A study of such distribution was necessary in a new method which he devised for measuring magnetic hysteresis, the principle of which method is that the mechanical work is measured when a specimen of iron is passed through a magnetic field, a method which does not require specimens of any particular dimensions or shape. Under these conditions the induction varies greatly from the centre to the end. In this method it is necessary to know the amplitude of the cycle, referred to as *b*, through which the whole specimen would have to be taken to give the same loss as that measured; if the distribution of the inductance, when the specimen is in the centre of the field, is known, the value of *b* can be calculated by an equation which he gives. To determine this distribution requires some time, and is tedious, and he therefore devised a method of determining its value in a simple and direct way; this is the subject of the present paper. From the results he found that the ratio of *b* to *B* maximum is constant as long as the centre of the specimen is not saturated (*B* maximum being the induction at the centre); also that this ratio varies only by a small amount for specimens of different relative dimensions, and is constant for all specimens whose length is less than 30 times the section; when this ratio is known the value of *b* can be determined by simply measuring the induction at the centre of the specimen; the value of this ratio when the length is less than thirty times the section is 0.768. This method can be applied over the whole range of induction used in practical work. The method of observation used in determining this is described and the results are given in detail. Fleming, in a paper on the

measuring of hysteresis loss in straight iron strips (see "Digest," July 3 and Oct. 2, 1897), determined the value of b and found that at a point of the specimen whose distance from the centre is a certain fraction of the half length the induction is always equal to b; the author finds this to be true as long as the centre is not saturated; also when the length of the specimen is less than thirty times the section; Fleming found this distance to be 0.56 of the half length, while the present author found 0.564; but the error in the value of b may be much greater if obtained by measuring the induction at this point as suggested by Fleming, as a small error in placing the coil would give a large error in the result; but if the induction at the centre is measured, a small error in placing the coil would give practically no error in the result.

ENERGY OF A MAGNETIC FIELD. Pellat. "L'Eclairage Elec.," Oct. 20.—An Academy paper deducing some formulas based on the quantity of heat absorbed or given out in order to maintain the temperature constant during the charge.

POWER TRANSMISSION THROUGH AIR. Trowbridge. "Sc. Am.," Nov. 19.—After a brief description of Tesla's new method of transmitting power through the air without wires, he refers to his own recent experiments with high voltages. He has increased the voltage obtainable with his apparatus to 3,000,000. Up to 1,500,000 volts the length of the discharge in air appears to be closely proportional to the e. m. f., but when this is exceeded the proportionality no longer holds, for with 3,000,000 volts the spark is only 7 feet, while it should be about 10 feet. The reason for this is that from both terminals there is a luminous brush discharge, and the resistance of the air diminishes under the action of such high voltages. A few experiments are described; in view of these he is led to believe that ordinary air under high voltages acts like a fairly good conductor, and he can conceive of such high voltages that the initial resistance might not be more than the resistance of metals. In employing such high voltages as Tesla suggests the great loss could only be obviated by shifting his entire generating apparatus far above the surface of the earth.

Electro-Chemistry and Batteries.

DEPOSITING METALS DIRECT FROM THE ORE. Hoepfner. "Elek. Zeit.," Nov. 3.—A reprint in full of his paper which was read at the meeting of the Union of German Electricians. It refers chiefly to his process as applied to copper and briefly to other metals also. His process is now in use in Germany, and has shown that it is a success; one installation, which is to be completed this fall, will have a daily output of 1000 kg of copper per day. The ores are first ground fine, then leached in a hot solution of copper chloride, which is said to dissolve the copper, silver, lead and nickel, while the solution is changed to cuprous chloride; it is then filtered, freed from arsenic, antimony, bismuth and iron by means of lime, and then freed of its silver; the solution flows in two parts through a vessel containing a diaphragm, an anode of carbon and a cathode of copper; in the cathode chamber the copper is deposited from the solution, while in the anode chamber the chloride set free combines with the solution, forming cupric chloride, which is then used again for dissolving more of the ore; the process is therefore completely cyclic without any consumption or loss of the liquid. Tests have shown that from an ore containing 3.37 per cent. of copper 91 per cent. is extracted in four hours, while only 3 per cent. of the iron is dissolved; in a longer time 98.5 per cent. of the copper was dissolved, while only 4 per cent. of the iron went into solution. The lead and nickel contained in the cathode chamber after the copper has been deposited are then also separated out, the former in spongy form and the latter in a solid deposit, absolutely free from copper, although containing a little cobalt. He then compares his process with the copper sulphate process of Siemens and Halske; the latter does not separate out the silver, and is therefore valueless for many ores; his process yields per ampere twice as much copper as the sulphate process, because he deposits the copper from a cuprous solution; it requires a voltage of only 0.8, and has a current efficiency of 90 per cent., so that 1 horse-power per day will deposit 44 kg of copper, as compared with 15 kg in the sulphate process; moreover, the silver, lead and nickel are also obtained, which is not the case of the sulphate process; the original ore, or other products containing much iron, can be used, and while a little iron is dissolved it can be separated out by a very simple process and becomes a valuable by-product. There is no objection to diaphragms if these answer their purpose and do not deteriorate. If the electrolytic processes, half a kilogram of coal will yield 1 kilogram of pure copper, or including the grinding and all accessory work, 1 kilogram of coal will produce 1 kilogram of copper; the process could be used even in countries where coal is expensive. This method solves at the same time the problem of getting the lead, nickel and silver in a state of great purity (but how is not explained). His electric process of obtaining bismuth has been in use for nine years. It also solves the problem of the deposition of zinc directly from the ores; such a process is only of use if a by-product of value is produced, which in his case is chlorine; he showed a sample of zinc deposited from the zinc chloride, which contains less than 0.05 per cent. impurities and was quite solid; he claims that no process for obtaining chlorine operates better than this one; the carbons last longer because no chlorine salts are formed and the operation is simpler, cheaper and more reliable. His zinc process has advantages over the usual distillation process; by means of the latter rich ores containing 40 per cent of zinc must be used, and it involves the loss of 15 to 20 per cent. of the zinc, while the electrolytic process gives much better results, as ores containing only 6 to 8 per cent. of zinc can be worked; the presence of lead does absolutely no harm; the zinc which is deposited is almost chemically pure; other valuable metals, such as gold, silver and copper, are also obtained; the value of the by-product—chloride of calcium—covers the greater part of the cost of the process; the preparation of the solution is not as simple as its electrolysis; he intends to modify his process so that the chlorine can be used over again, as in the copper process; the voltage is only 1.0 to 1.2, while when both free chlorine and zinc are produced it requires 3 to 4 volts; for one kg of coal about three-quarters to 1 kg of zinc can be obtained, while in the distillation process from 5 to 6 kilometres of coal are required. In conclusion he refers briefly to the possibilities of obtaining electrical energy by an electrochemical process; he suggests inverting his process, so that the metals are dissolved, yielding a current, the oxide of the metal being then reduced again by means of coal; he thinks he has already found a method of doing this.

ELECTRIC DEPOSITION OF COPPER. Brown. Lond. "Engineering," Nov. 4.—A note stating that the description of the Dumoulin process (see "Digest," Nov. 12) was wrong in so far as it refers to the use of animal matter for making the deposit smooth. It was found in practice in the use of the Elmore process that the agate burnishers were not the cause of the foliation, but on the contrary were found to give better results than any other burnishers.

GALVANIC DEPOSITS ON NON-CONDUCTORS. Knothe. "Elek. Anz., Oct. 20.—A description of the best process for coating objects that are non-conductors. It is hopeless to try and form a metallic coating by chemical means, and the only satisfactory methods are to use graphite or a coating obtained by a solution of silver. The graphite method is briefly described, but is considered inferior to the silver solution method. For the latter a solution of nitrate of silver in alcohol is used, the body being dipped into it or coated with it; it is then placed in the vapor of phosphor or sulphide of hydrogen, which converts the coating into a conductor; the sulphur method is preferred because the coating adheres better and the process may be repeated if not successful at first, while that is not the case when phosphorus is used. The silver solution should be made neutral with ammonia, as it will then adhere better to greasy surfaces and hastens the sulphiding process. With such a coating the first deposit is formed a little more rapidly than with graphite. The object should have one or more copper conductors attached to it to start the deposit; these starting points are best placed in the deeper portions of the object. The object should first be treated so that all pores are filled and that it becomes waterproof; this is done with wax, tallow or a mixture of the two and collodium; wood is best boiled in linseed oil. The silver solution is made of 2 parts by weight of silver nitrate, 4 parts water, 5 parts ammonia of 0.9 sp. gr. and 6 parts of absolute alcohol; when the ammonia is added a brown precipitate is first formed, but is re-dissolved. After being coated with this it should be completely dried and freely exposed to the air for some time; it is then subjected to the action of the hydrogen sulphide; this process may be repeated as often as is necessary. The current for depositing the copper should be only 0.5 to 1 ampere per sq. decimetre of surface and at 0.75 to a maximum of 1.5 volt. The copper solution should consist of 3 to 4 parts of water to 1 part of the sulphate and 2 to 8 per cent. of sulphuric acid. The hydrogen sulphide is obtained by pouring dilute sulphuric acid on iron sulphide. A metallic deposit on glass, porcelain, etc., is best obtained by coating it first with gold paint and then firing, after which the deposit can be made. Or the objects may be covered with a coating of wax or resin, which is then coated with a silver solution as above described. Celluloid may be coated in the same way. Collodium or celluloid may also be coated with a solution of phosphorus in ether-alcohol added to a solution of concentrated silver nitrate; the object is then painted with the creamy precipitate which is formed. To try to use copper salts in place of the silver salts would not give good results.

ALKALI MANUFACTURE.—Lond. "Elec. Eng.," Nov. 4.—A brief description of the Hargreaves-Bird process, other descriptions of which have already been referred to. The anode chamber, containing a strong salt solution and carbon electrodes, is separated by partitions of asbestos cloth from the cathode chambers, a sheet of copper wire gauze being pressed into the outside of the partitions. The novel point of the method is that although these partitions are quite impervious to salt solutions under ordinary circumstances, yet when an electrical current passes from the carbon to the wire gauze, metallic sodium passes through the partition and is converted into caustic soda by means of steam. Fourteen electrical horsepower could decompose 15 cwt. of salt per week; this amounts to about 117 watt minutes per gram of salt decomposed; the e. m. f. is 2.2 volts; theoretically the energy necessary to decompose one gram of salt is 61 watt minutes.

WHITE LEAD.—"Elec. Rev.," Nov. 16.—An anonymous communication calling attention to an electrical process which is in operation in Brooklyn producing from 5 to 6 pounds of white lead per hour, or 2 pounds per electrical hp-hour. A solution of ammonium nitrate and bi-carbonate is used; the process is continuous, and the cost depends only on the cost of the electrical energy; the product is said to have a covering capacity equal to that of the best quality.

GOLD FROM SEA WATER.—"Eng. and Min. Jour.," Nov. 12.—An illustrated description of the "accumulator" used by Jernegan with which he professes to have extracted the gold from sea water; it is given as a matter of curiosity, as it has no scientific in-

terest. It consists simply of a vessel into which the sea water is forced near the bottom; there is a suspended platinum anode, while the cathode is mercury at the bottom of the vessel, and in this the gold is said to be absorbed. The experiments are being continued by the president of the company.

Units, Measurements and Instruments.

MEASURING EARTH PLATE RESISTANCE FOR TELEPHONE CIRCUITS. Nowotny. "Zeit. fuer Elek.," Oct. 23.—After discussing the methods in general, he describes one of them in detail and gives a number of comparative results. The measurement of the resistance to earth is important, whether it is used for single-wire circuits or only for lightning arresters; it is therefore important to measure numerous earth resistances in a large telephone station, including the earths at the numerous subscribers' ends, and a simple method is therefore desirable. If there are two other earth connections which can be used conveniently, then the well-known method can be used in which all three of the earth resistances are determined; if there is only one such additional earth connection the Wiechert method gives good results; but often there is no such additional earth connection, and one would have to be made, which is tedious and expensive; this can be obviated by using the earth connection at the central station, together with the line wire, as the second earth, in measuring the resistance of the earth plate at the subscribers' end. For the measurements he prefers to use the bridge method with interrupted currents and a telephone; when the line wire to the station is very long he prefers using another earth connection nearer at hand. In this Wiechert method the two earth plates, connected in series, are made the two arms of a Wheatstone bridge, one of them, however, having also in series with it a known resistance; the other two arms are adjustable resistances, such, for instance, as a slide wire resistance; one of the poles of the telephone which is used in the place of the galvanometer is connected with the sliding contact, while the other is connected to earth through any convenient earth contact whose resistance does not enter into the calculation. This enables the ratio of the two earth resistances to be determined; they are then measured in series, which gives their sum, and from these two determinations each of the earth resistances can be calculated. He found that better results are obtained when the battery and the telephone are transposed, one end of the battery being connected to the so-called earth contact. As a check, the two earth-plate connections may be reversed and the bridge measurements repeated. The tabulated results of his tests show a sufficient agreement for all practical purposes.

ALKALIMETRIC METHOD OF MEASURING SPARK DISCHARGES. Cardani. "Nuovo Cimento," 7, p. 105; noticed briefly in "Science Abstracts," Oct.—With a certain solution, through which a number of sparks has been made to pass, he measures the amount of soda liberated by each spark, from which the electrical quantity discharged by the spark may be calculated. The amount of soda set free is determined by adding to the solution another, which will bring it back to the original color, the amount of this second solution being a measure of the quantity of soda.

MAGNETIC FLUXES IN METERS AND ELECTRICAL INSTRUMENTS. Campbell. Lond. "Elec.," "Elec. Rev.," and "Elec. Eng.," Nov. 4.—A brief abstract of a Physical Society paper in which he describes how he measured the magnetic fluxes and fields in certain instruments in order to determine the order of magnitude of the flux density and the total flux. The methods are described in detail, and important deductions are made (although not in the abstract), one of them being the influence of the earth's field.

TESTING SHEET IRON. Roehr. "Elek. Zeit.," Oct. 27.—He gives the results of some measurements made with the Koepsel apparatus by both the step-by-step method with continuous current and the direct method with alternating current and a wattmeter. He shows that that apparatus, when properly used, gives very correct and reliable results; the hysteresis loops agreed very well; tables of results are given. He states that the Steinmetz coefficient can be used only in connection with the hysteresis loss, and claims that too much importance is given to it because, according to the Reichsanstalt, it may vary from 30 to 40 per cent. It is much more important in forming an opinion of sheet iron to have the characteristic hysteresis loop and to determine the loss directly from it. He found that a plate taken from the edge of a large sheet gave better results than one taken from the middle. The amount of carbon contained is a very good indication of the loss, and not, as is often supposed, the amount of manganin; a high percentage of carbon diminishes the loss quite appreciably. It has been possible to reduce the loss from 10,000 to 6000 ergs per cb cm through the aid of proper investigations. A table compares the results obtained with the alternating-current and the continuous-current methods; the second method has advantages over the first, as it gives the curve of the loop and the amount of coercive force and resonance, but a serious objection is the accurate determination of the cross-section of the sample, which latter is more easily done by the second method.

PHOTOMETER.—Lond. "Elec." and "Elec. Rev.," Nov. 4.—A brief, illustrated description of a new form of Preece-Trotter photometer made by Nalder. It is as accurate as the old patterns, but its weight and bulk are reduced to a half, while the cost is considerably less than that of the original. An amyl-acetate lamp is used in place of the incandescent lamp and accumulator. The apparatus consists of a very short horizontal tube mounted on a tripod; the screen is on the upper side of one end, and is illuminated on one side by the lamp by reflection from a movable screen, the inclination of which can be changed so as to vary the light falling on the fixed screen; the inclination is read off by means of a pointer and scale, the reading giving the illumination directly in candle-feet.

STANDARD HIGH RESISTANCES. Fawcett. "Phil. Mag.," Nov.—A reprint of his short Brit. Assn. paper describing a high resistance, which is both cheap and reliable. It consists of a thin metallic film deposited in vacuum from a metallic cathode; by making the cathode of a grid of wires the deposit on a parallel plate of glass will be quite even; if the wires are of two different metals the deposit seems to be an alloy of these; in his experiments gold-platinum films were used exclusively. These films should be boiled for several hours under reduced pressure in a non-conducting, chemically inactive oil; the film is then hermetically sealed in its oil bath and the vacuum maintained; after this treatment the resistance undergoes no further measurable change. The temperature coefficient decreases as the thickness of the filament decreases, and it may therefore be possible that it may be made negative, and therefore also zero. The filament thus obtained is scratched with a needle with parallel lines extending from either side to near the other so as to form a zig-zag strip, the scratching being continued until the resistance has the required value. It has the following useful properties: Constancy of resistance, small temperature coefficient, negligible capacity, negligible self-induction, and ease of adjustment to definite value. A megohm was subjected to 105 volts for five days without experiencing any detectable alteration.

TEN CANDLE-POWER STANDARD. Harcourt. Lond. "Engineering," Oct. 28.—A brief notice of his Brit. Assn. paper in which he described his new 10-candle pentane standard lamp. A similar one of 16 candle-power can be constructed on the same principle.

INFLUENCE MACHINE. Pidgeon. Lond. "Elec.," "Elec. Rev." and "Elec. Eng.," Nov. 4.—An abstract of a Physical Society paper. "The machine consists of a pair of glass discs, rotating in opposite directions upon a spindle. They are partially covered on one face with narrow radial sectors of tinfoil, each provided with a small brass knob. This face of the disc, including its sectors, is then coated with insulating wax, leaving only the knobs projecting through the wax. Two earthing brushes pass through two insulated fixed inductors and support them. The inductors are kept charged by exploring points connected to each, and placed so as to collect electricity from the revolving discs. By means of brushes the sectors on each of the discs are successively earthed at the moment they pass the fixed inductors, i. e., at the moment that their capacity is a maximum; and they are made to deliver up their charge to the main collecting brushes at the moment when they are electrically farthest from the inductors, i. e., when their capacity is a minimum. Hence, if there is no loss of electricity in the process the potential at the collecting brushes is proportionately high. Each sector of a particular disc, as it moves away from its inductor with rising potential, induces a corresponding potential on the sectors opposed to it on the second disc; this action is cumulative. The thick coating of wax restricts leakage to the small area of the contact knobs, so that surface effects of dirt and moisture are minimized." In the discussion J. H. Thomson called attention to the advantages in mechanical construction; he also found that about 80 per cent. of the power used to drive it was wasted in mechanical friction and of the remaining 20 per cent. a great deal was lost by leakage. The Lond. "Elec. Rev." says that one of the merits of this machine is its absolute immunity from the evils arising from surface moisture and dust; this mixture of paraffin wax and resin adopted does not commend itself, as the wax itself absorbs moisture and the resinous mixture retains the electrical charges.

Telegraphy, Telephony and Signals.

THE TELEPHONE IN GREAT BRITAIN.—Lond. "Elec.," Nov. 4.—Extracts from the official report of the parliamentary committee; it is chiefly of local interest.

HERTZIAN TELEGRAPHY.—"L'Eclairage Elec.," Oct. 8 and 15.—An illustrated abstract of the article of Ducretet noticed in the "Digest" Oct. 8.

ELECTRICAL ALARM. Ebel. "El'ty," Nov. 16.—A reprint of the article noticed in the "Digest" last week.

PERSIA.—"El'ty" and "Elec. Rev.," Nov. 16.—A reprint of the short article noticed in the "Digest" last week.

Miscellaneous.

PRESIDENTIAL ADDRESS. Preece. "Elec. Eng.," Lond. "Elec." and "Elec. Rev.," Nov. 4.—The beginning of a reprint in full in the first and a very full abstract in the latter two journals, of his presidential address before the Institution of Civil Engineers. The first part, chiefly of local interest, refers to the Government examinations and to technical education in Great Britain. He refers to the generous and enlightened policy of banks in Germany, which give their financial support to new industries, whereas in England this is done by syndicates with terribly overloaded capital. In discussing telegraphy in Great Britain he gives the following mileage of wire: General post office, 435,000; railway companies, 105,000; United Colonies, 387,066; submarine cables, 183,400. Total, 1,111,366. This refers to the present time. He refers to the successful use of a serving of brass tape in sea water cables to protect them from the "limnoria terebrans," a crustacean which bores through

the gutta percha; he calls attention to the declining supply of gutta percha and to its questionable purity; the supply fails to meet the demand. He refers favorably to paper insulation; the lead-covered paper cables, which are used largely in streets of English cities, are very satisfactory; he is now laying one of seventy-six wires between London and Birmingham. He refers to the competition of the telephone, stating that some such instrument as the electric typewriter or the telautograph is needed. Regarding wireless telegraphy he remarks that sensational experiments for booming a financial enterprise are not processes that commend themselves to that institution. In referring to telephony he states that speech is now practically possible between any two post offices in the United Kingdom, and theoretically possible with every capital in Europe; the progress in the use of the telephone in Great Britain has been checked by financial complications, it being in the hands of a company promoter, and has remained the shuttlecock of the stock exchange; telephony is an imperial business like the post and the telegraph, and it ought to be in the hands of the state. Some figures are given showing that the Government did well in purchasing the telegraphs; he shows that the present magnificent system has been built virtually out of the revenue; the tariff is very cheap and press dispatches are transmitted below cost price. The total number of telephones in use (presumably in the United Kingdom) is 152,019. He discusses the application of the telegraph to railway management and gives some tables showing the extent of its use in that country. In discussing the subject of electric light he gives a table showing the position of the industry in that country and the United States at the present time; some of these figures for the United Kingdom and the United States respectively are as follows: Number of central stations, municipalities, 72 and 338; companies, 63 and 2251; kw capacity, municipalities, 44,219 and 41,193; companies, 24,344 and 578,051. He urges local authorities to combine the electric lighting and railway power stations, claiming that it will reduce the cost of the current for both. The subject of electric lighting on board ship is discussed; a table gives the electrical energy used on a first-class battleship; another gives some information concerning the British Navy. The reprint is to be continued.

The Dow Engine.

A paper which was read by Mr. Josiah Dow October 1, 1898, before the Engineers' Club of Philadelphia and reprinted in the Proceedings, describes most completely the novel and interesting details of the engine of his design and known as the Dow engine.

After taking up historically the efforts of Mr. George H. Corliss, with whom Mr. Dow was associated, the reasons for the remarkable success of the Corliss improvements are detailed in the paper somewhat as follows: One of the most serious losses in steam-engine work is initial condensation and re-evaporation during exhaust. This can be to a certain extent eliminated by multiple expansion, which reduces the limits of the cycle of temperature changes through which the cylinder walls must pass, and also by reducing not only the volume of the clearance, but particularly the surface area of the clearance space. The valves should be mounted as close to the cylinder limit of the port as possible. They should not require too much movement to effect the opening and closing of the ports, and they must be actuated by the least possible exertion of power. These favorable conditions, with others, are possessed by the Corliss system, and have caused its success. In this system, however, they are combined with the detachable or "tripping" valve gear, which limits the speed to about 100 or 120 r. p. m., a rate too low for economical direct coupling to electrical generators, unless the lattter are of very large outputs. The advantages of gravity balance of the reciprocating parts obtained by means of two cylinders side by side, with cranks set 180 degrees apart, are noted, after which the Dow engine itself and its action are described as follows:

This engine is a double vertical compound, the present construction using steam of 125 to 130 pounds boiler pressure, and intended to run at about 150 r. p. m. The cylinders are placed as closely together as possible, side by side, permitting only room enough between them to provide for the valves, with their passages, and non-conducting spaces to prevent destructive loss of heat, which is further secured through the whole being surrounded by a space filled with an efficient non-conductor, and covered by lagging, preferably of wood. All the valves and steam passages have their positions between the cylinders, not only to avoid any possible loss of heat from them, but to facilitate the transfer of steam from one cylinder to the other and for compactness' sake. with the use of a simple operation of the valves. The final exhaust passage is, however, completely separated not only from its cylinder but from the steam passages, by ample non-conducting spaces filled, by preference, with "magnesia asbestos." The first cylinder exhausts through very short passages at either end—merely continuations of the ports—directly into the second, the up stroke of the first coinciding with the down stroke of the second.

The vertical arrangement of cylinders and connections is chosen to aid compactness and to facilitate the desired balance. The vertical form also permits the base and foundation to be compact, which is important when space is costly, particularly in the large cities, where most needed for electrical, traction and manufacturing purposes. The valves (see Fig. 1) are placed as closely as possible to the interior of the cylinders, as with the Corliss engine, but there are only two to each cylinder, the induction and eduction for each being combined in one; yet the passages for the full steam and the exhaust are completely separated in position and by non-conducting spaces. There are but four valves for the two cylinders, where the Corliss engine requires eight, and all are actuated by one wrist-plate instead of two, as with the Corliss engine. The events of the valves are so arranged that the beginning of exhaust from the high-pressure cylinder becomes directly the initial steam for the low-pressure, the lead for both coinciding and in control of the valve at the first cylinder, the valve at the second cylinder being always open in time to permit its free passage. The work in each cylinder at normal load and pressure is exactly the same, and the weights of the reciprocating parts are balanced against each other by means of the pistons being cast hollow, that the smaller one may be filled with sufficient lead to make its weight equal to that of the larger. The high-pressure valves (see Fig. 2) are cylindric in shape and so constructed that the induction steam passes entirely through them from end to end. The steam chamber is placed directly against the high-pressure cylinder, and at top and bottom is connected with the valves by means of passages in the casting, which lead completely around both their ends, from which, through ample openings, steam freely enters; but to the outside of the body of the valves no steam can obtain access from this chamber, being prevented by packing rings, which have their bearings upon seats at either end of the main portion of the valve. In this manner pressure, acting upon the valve, is entirely regulated from its own interior through means of the steam port at one side, and at the opposite side the balance port, arranged with steam-tight packing strips, and with sufficient area to secure a firm seat against both cylinder and exhaust ports, while passages outside the bushing into which the valve fits communicating with the cylinder ports complete the balance against the changing pressure within the cylinder. The valve receives always the same degree of movement, regardless of the point of cut-off, and, consequently, no ridges can form in the seat where a smooth, perfect contact is maintained, improving with wear, while but little force is required for actuation. Exhaust is effected by this valve through a depression in its side formed to complete the passage which connects the cylinders at the proper time.

The valves in second cylinder need no cut-off, its steam expansion being a continuation of that begun in the first; therefore, their construction and action are very simple. They open the connecting passage just before the high-pressure valve releases the steam, and close it with enough time before expansion is completed to leave the steam within it of higher pressure than the terminal of second cylinder; the passage is opened again when compression has brought the pressure in this cylinder back to the same degree, and the completed compression is reached with a pressure about equal to the terminal of first cylinder; this contributes to smoothness of action. These valves also control the exhaust and compression of their own cylinder. Both sets of valves, notwithstanding their own peculiarities, preserve the setting, seating, and movement peculiar to the Corliss system; but, as one valve controls both inlet and outlet, the necessary "dead spaces" at the ports are reduced one-half.

The single wrist-plate, shown in Fig. 3, controlling the main movements of thes valves, yields its well-known advantage of quickening the action just when most needed, while giving almost perfect rest to the valve during the ingress and egress of steam. The cut-off movement is taken from the "cross-head," that it may be simple in connection and accomplished at identical positions of the piston for both directions of its movement with its own angular advance. This movement is communicated to a vertical lever which has a slot through its upper limits, in which is carried a sliding block, having connection with the governor, from the centre of which links are attached leading off at either side to rocker arms, which also carry connecting rods leading on one side to the upper, and on the other side to the lower, valve gear. Cut-off is always completed at an identical position of these rockers, and they are so arranged that, if the block is down in the slot, the cut-off will come much sooner than if it be up, the range following such part of the whole stroke as may be desired, from no admission of steam at all to a coincidence with the closing effected by the main gearing at about seven-eighths stroke.

The connecting mechanism from the cut-off lever to the valve gear is so constructed that the governor can only move the valve mechanism between the proper limits of no admission and admission of seven-eighths of the stroke, any motion of the governor beyond these limits being taken up by toggle joints in the connecting mechanism, and not transmitted through to the cut-off plate. The immediate valve gear is set upon a "bonnet" as with the Corliss engine. It comprises a crank keyed to the valve stem, and connected through a toggle joint with another crank oscillated by the wrist plate. The middle pin of the toggle joint carries a roller which rides in the groove in the cut-off plate, which in turn oscillates, owing to its connection, as described above, in time with the main cross-head, the range of its motion being determined by the governor. This groove is so proportioned as to give the valve a quick cut-off determined solely by the governor and the cross-head position, all the other events of the valve being dependent solely on the movement of the wrist plate; thus a positive-action valve is obtained with all the advantages of the Corliss detachable. The advantages of the whole design may be summed up as follows:

In compounding, the second cylinder receives its steam directly from the first through short passages no longer than the ports of the cylinders, and closely guarded against radiation of heat, the expansion of steam, stroke for stroke, being simply a continuation of that begun in the first, without the interposition of a receiver or excessive connecting passages, thereby recovering initial condensation by direct re-evaporation into the next cylinder; also, saving much in intermediate condensation, convection and radiation, while avoiding the necessity for reheating in an attempt to overcome these difficulties.

The steam chest is between the cylinders, so combined with the first cylinder and its steam passages, so guarded from the exhaust passages, and the whole within so efficient a covering insulating from loss of heat that the smallest degree of loss in energy is suffered from this cause.

The valves—one of which takes the place of two, as with the original Corliss construction—being in themselves continuations of the steam chamber, hold the steam always close against the cylinder ports, while they are balanced for easy action not only against their contained pressure but also against the varying force within the initial cylinder, thus requiring but little power to operate them, even with high pressures of steam.

Clearance behind the piston, and dead spaces between the closing of the valves and the cylinders, in both cubic contents and area of surface, are greatly reduced, with their accompanying initial condensation. This is largely owing to the advantage of using for both cylinders one port for induction and eduction.

The balance of the actuating parts of the engine, for both gravity and the energy delivered by the pistons, secures smoothness of action and saving in friction.

Great compactness is readily attained, particularly with the vertical construction shown. This gives the engine the advantage, now much sought, of occupying a very small area in proportion to the power developed.

The valve-gear and cut-off are made entirely positive in action, and, while

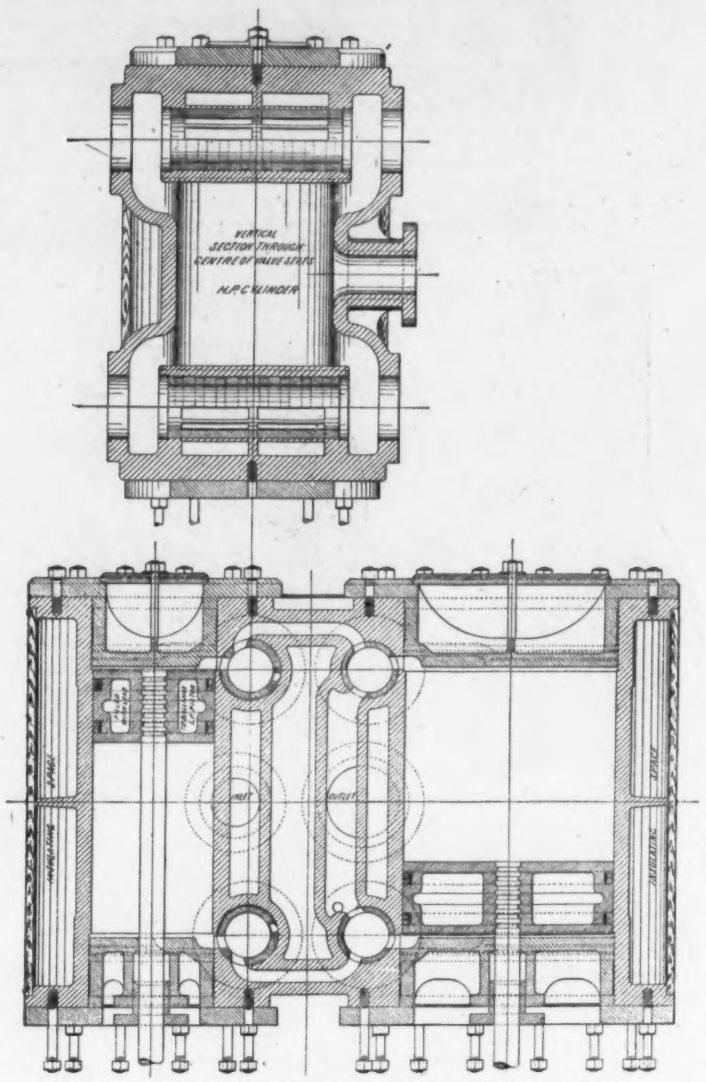


FIG. 1.—SECTION THROUGH CYLINDERS AND VALVE GEAR.

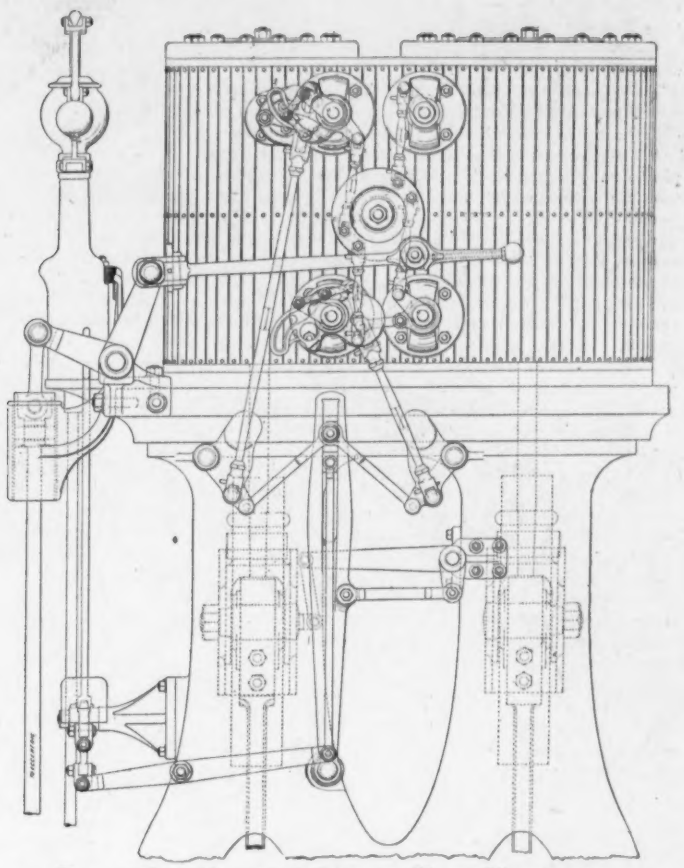


FIG. 3.—SIDE ELEVATION SHOWING VALVE MECHANISM.

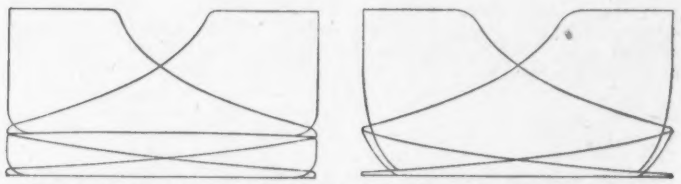


FIG. 4.—CARDS WITH AND WITHOUT AN INTERMEDIATE RECEIVER.

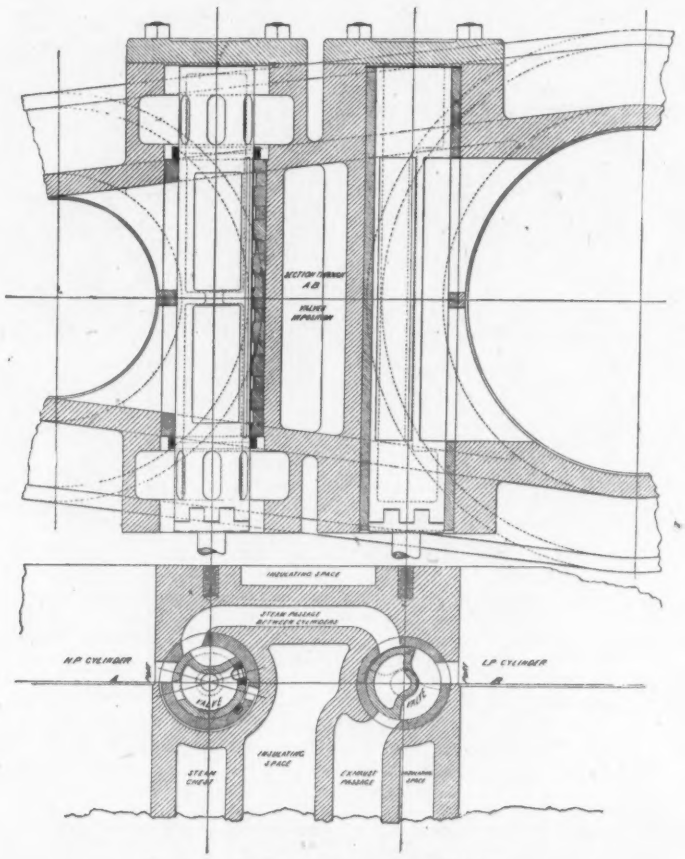


FIG. 2.—DETAIL SECTIONS OF VALVES.

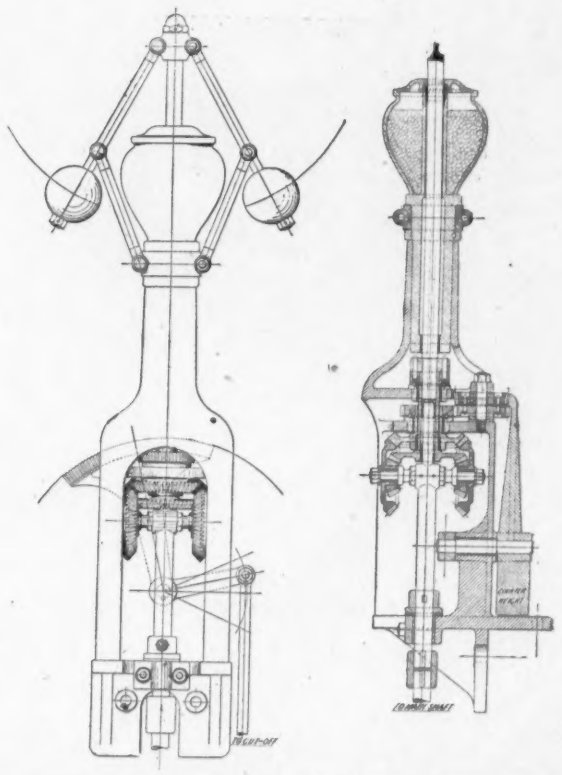


FIG. 5.—ELEVATION AND SECTION OF CHRONOMETRIC GOVERNOR.

retaining all advantages of the Corliss gear, they avoid the disadvantage of the "drop" and "dash-pot."

A cut-off is provided, always smooth in action and positive in proportion to the velocity of the engine.

These advantages help greatly to do away with the necessity for low speed, which has so much held back the progress of the Corliss system, and a velocity can readily be attained sufficient to meet all needs.

A cut-off can be effected with equal readiness from a point before the beginning of the stroke up to seven-eighths of its travel, where it merges perfectly into the closing of the valve as effected by wrist-plate action alone, with a full opening of the induction port at once, to be held until the point of cut-off, regardless of its place in the stroke, while leaving, as is essential with the Corliss system, all the other events of the valve entirely undisturbed by its change. With the original Corliss engine a cut-off can be effected only within less than the first half of the stroke, while the "drop and dash-pot" arrangement obliges the valve to be kept in motion, with the steam port slowly opening until the cut-off is made.

The engine effects the cut-off with an equal distance from either end of the piston travel for all points at which it may take place, it being perfectly corrected for angular advance of the connecting rod and consequent position of the piston. This is also true of the wrist-plate connection, which is corrected for angular advance of the eccentric rod.

The valve-gear is not only very compact and simple, but always positive in its action, while one wrist-plate for both cylinders directly controls lead of the initial steam, lead of exhaust and closing of exhaust for compression, the only event separated from its action being the cut-off, which is entirely independent.

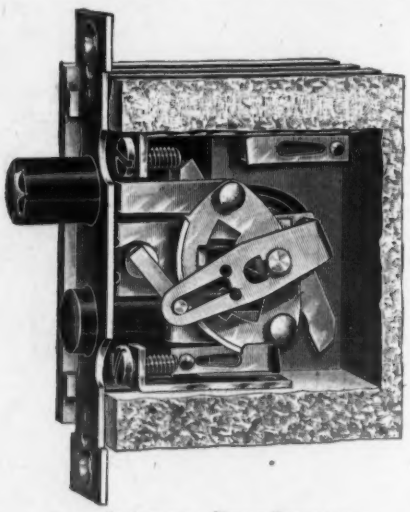
The engine is governed by the Dow chromometric governor, which is shown in Fig. 5. This differs radically in principle from the ordinary fly-ball governor, although resembling it somewhat in appearance. The position of the valves is not dependent on the position of the fly balls, which act not as centrifugal weights, but as a rotating pendulum, tending to maintain an isochronous speed. This pendulum is driven by an elaborate differential bevel-gear train, the difference in speed between the shaft of the engine and the rotating pendulum being taken up in a sector-shaped gear actuating the valve cut-off mechanism. Thus, so long as the work done on the pistons is not exactly balanced by the load and there is a tendency toward acceleration or retardation of the speed, this acceleration or retardation itself continues to move the valve mechanism toward a shorter or longer cut-off position, respectively, until the two speeds are exactly equal. The governor is naturally remarkably sensitive and yet free from all tendency to hunting.

A Serviceable Push Switch.

The push switch represented in the accompanying illustration is designed particularly for use in private houses, public buildings, hotels, etc., and is recommended by the manufacturer (the Hart & Hegeman Manufacturing Company, 52 High Street, Hartford, Conn.) for the ease with which it can be operated, its durability, the ease with which it can be installed, and its ample carrying capacity. Mechanically, this switch is strong, the case being one piece of porcelain, and electrically it is designed to stand heavy service.

This switch is made in the single-pole, double-pole and three-way types. A 10-ampere switch was recently tested on circuits carrying 15 and 20 amperes at 115 and 230 volts, the circuits being opened and closed 3200 times altogether. The switch worked freely, and no undue heating or arcing was observable. After this ordeal it was found to be in good order, hardly any of the effects of the severe work being noticed.

The contacts are of the "knife-switch" type, and the switch plates are well



Improved Push Switch.

insulated. The switch has a quick and positive action, and gives a long break. One important feature that will appeal to the contractor and wireman is that it can be very easily and quickly wired.

Some New Telephone Apparatus.

The Hipwell Manufacturing Company, 100-102 North Avenue, Allegheny, Pa., has for some time been manufacturing magneto generators and other telephone supplies for some of the largest telephone companies in this country. This company claims to be the only manufacturer of independent telephones that has complete facilities to manufacture a 'phone from the raw material. Its plant for the manufacture of telephone apparatus is claimed to be second to none in the country, and the instruments are built up entirely from the raw material. It has been the company's desire, in producing these instruments, to supply apparatus superior to anything in the market. The illustrated sheet of the telephone apparatus manufactured by the Hipwell Company shows a line of long-distance telephone instruments, extension bells, magnetos, transmitters, receivers, fuse and lightning arresters.

The illustration shown below gives a view of a complete subscribers' long-distance outfit. The receiver is of the bipolar type, and is said to be unaffected by temperature changes. Its magnets are made of the best tungsten steel, the pole pieces being nickel-plated to avoid rusting.

A Slow-Speed Laboratory Motor.

The machine illustrated herewith has been designed especially to meet the demand for an alternating-current motor for laboratory work, such as the driving of static machines, dental apparatus, small pumps, etc. It is intended to

Long Distance Set.

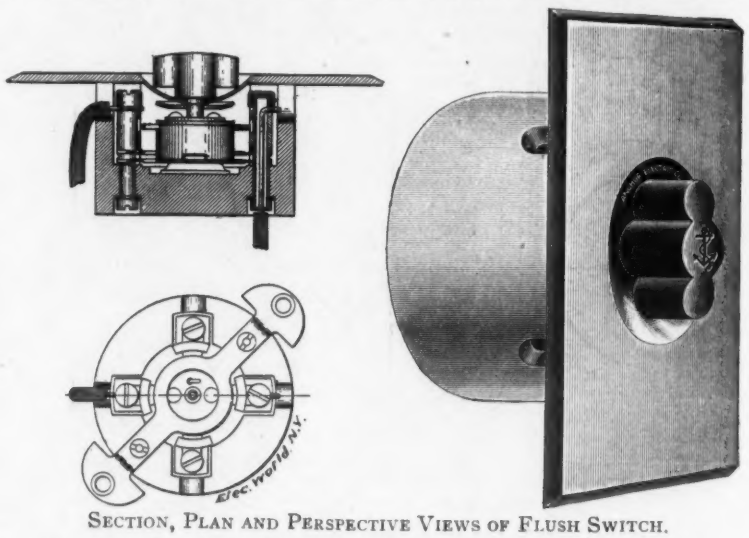
Slow Speed Alternating-Current Motor.

fill a gap in the alternating-current motor line, and develops three or four times the power of the ordinary 16-inch fan motor. It is made in four sizes, two of which are designed for 16,000 alternations, running at speeds of 1200 and 1000 r. p. m., and two for 7200 alternations at speeds of 540 and 450. The slow speed, it is stated, gives the machine quite a strong torque at the pulley, and makes it much more convenient to adapt to direct belting or to gearing, without the intervention of countershafts.

These machines are manufactured by the Emerson Electric Manufacturing Company, 714-718 St. Charles Street, St. Louis, Mo.

Improved Flush Switches.

In the accompanying illustration is shown a flush switch which has the non-current carrying parts of the movement built up of nickel steel, thoroughly insulated from the moving contacts and encased in a heavy porcelain cup fastened to a strap and yoke, by which it is screwed to the wall. This device is manufactured by the Anchor Electric Company, Boston, Mass. Other fea-



Section, Plan and Perspective Views of Flush Switch.

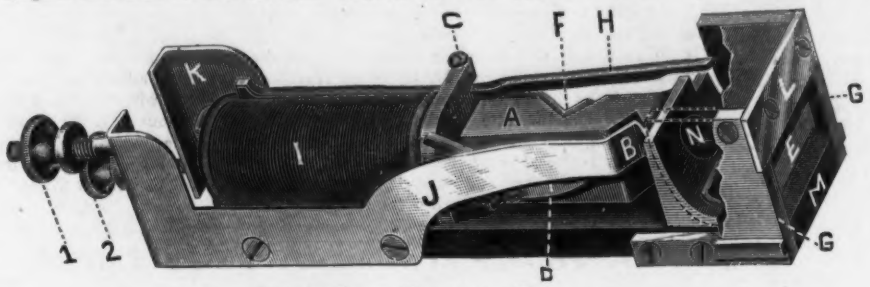
tures of this switch are the accessibility of the binding posts, giving face connections, and the absence of slack wire. The strong claims made for these switches are not based entirely on the fact that they are designed especially to insure long life, perfect action and ease of wiring, but on the competitive wiring tests resulting in their favor and to laboratory tests made by some of the most prominent engineers. These tests demonstrated that the action was sufficiently quick and the surface contact sufficiently large to open and close a circuit of double the rated potential at double the load for upward of 500 times in succession without perceptible heating. In the endurance tests the switches were operated upward of 12,000 times at full load without materially impairing their efficiency.

Much annoyance has been experienced by contractors through the fracture of porcelain on flush-snap switches. The Anchor flush switch has a strap or fastening yoke extending across the switch, which bears the tension and reduces to a minimum the tendency to fracture. The porcelain is, besides, ex-

tremely tough and non-absorptive, and is modelled so as to occupy the smallest space, at the same time possessing the maximum strength. The binding posts are so arranged as to enable connections to be made easily from the front, when in deep sockets, leaving no slack wire and requiring but a fraction of the time usually needed in wiring up flush switches. The action is said to be so quick that the switch will operate successfully on a circuit of double the designed potential and double the load if necessary. Flexible spring handles are used, and the anchor stamped on the handle is claimed to be a safeguard against intentional or careless substitution.

Spring Jack, Drop and Coil for Telephone Express Switchboard.

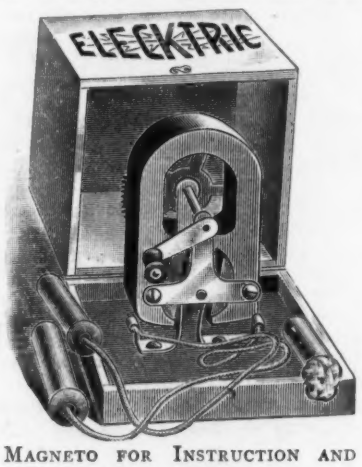
The accompanying illustration gives a perspective view of the jack drop and magnet coil used in the Western "Express" switchboard, manufactured by



SPRING JACK, DROP AND COIL.

the Western Telephone Construction Company, of Chicago. It is claimed that this spring jack and drop is the most simple and ingeniously arranged of any heretofore used to perform the same purpose. The drop is mechanically restored with the plug as it enters the jack to make a connection with a subscriber, and is said to be, with the one used on the company's No. 1 boards, the only self-restoring switchboard drop that is positively free from infringement of patents. Referring to the cut the armature shown at *H* is arranged with an adjustable spring, which prevents the sticking of the armature to the magnet head or pole, and never fails to release the drop or shutter when the subscriber calls. The night-bell connection is made by the upper edge of the drop making contact with two springs directly over the drop, which are connected with the night-bell circuit.

In construction the spring jack consists of a solid brass casting, *A*, bored out for the plug, as shown at *N*. *J* and *K* are the line-wire conductors, and form the tip-spring connection with the plug at *F* and sleeve-spring connection with the plug at *B*. The drop shown at *E* is insulated and hinged to side pieces, *G*, *G*, which are connected with the night-bell circuit. The cut-out spring shown at *D* is disconnected from the sleeve spring *J* when the plug is inserted in the jack, thus cutting out the coil. Thumb nuts 1 and 2 secure the jack in position and connect with the line terminals. The magnet *I* is mounted on the hard-rubber base *M*, and can be easily removed. The armature swings on the pivot in front of the magnet head, and is secured by the pivot screw *C*. Only two springs are used in connection with the drop and jack. The side pieces *G G* are provided with lugs which fit into grooves in the vertical strips in front of the board, which hold the jack in position and relieve it from all strain as well as from the effects of contraction and expansion. The construction of the jack is so simple that the liability to get out of order has been reduced to a minimum, and it is said to be free from danger of short circuits.



MAGNETO FOR INSTRUCTION AND EXPERIMENTS.

A Small Magneto.

The Knapp Electric & Novelty Company, 47 Warren Street, New York City, is manufacturing a little magneto which is designed for instruction and experimental work. It is simple in design and well finished. Each outfit includes hand electrodes, sponge electrodes for application to afflicted parts, etc.

This little machine corresponds with all the other products of the Knapp Company in quality of workmanship and material in its manufacture, and is excellently adapted for the use of young experimenters.

The Wright Discount Meter.

An efficient instrument for the determination of the discounts of the Wright demand charging system is now put on the market by the Wright Discount Meter Company, 1012-1013 Monadnock Block, Chicago, of which Mr. Martin J. Insull is manager.

The Wright demand system has been much discussed in electric lighting conventions and in the technical press, and has already been adopted by several of the largest Edison companies, notably those in Chicago, Boston and Cleveland, although the discount meter has not as yet been actively pushed on this market.

The appearance of the meter is shown in the accompanying illustrations, of which Fig. 1 is a diagrammatic view. Fig. 2 shows the meter with the front hinged door closed for sealing, and Fig. 3 shows the door open and the working parts of the meter tipped out toward the restoring position. The meter consists essentially of a U-tube *L* filled with a colored liquid, a bulb, *H B*, containing air at one end and a graduated indicating tube, *I T*. Surrounding the bulb *H B* is a conductor in series with the load and so arranged that it heats the air within, which action forces the colored liquid over the siphon, whence it drops into the tube *I T*, from which it cannot be restored except by the inspector at the end of a predetermined interval. The greater the maximum load occurring at any time the greater is the heat developed in the bulb *H B*, and the greater is the amount of liquid spilled over into the indicating tube. This at the end of any period, then, thus gives an indication of the maximum load which has occurred during that period. Very brief loads, such as short circuits, etc., do not affect the instrument, which has a time lag such that if

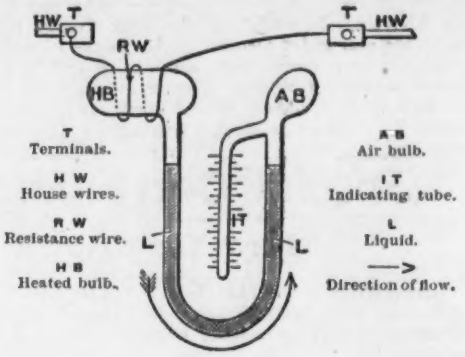


FIG. 1.

the maximum load last five minutes the meter will register 80 per cent.; if ten minutes, 95 per cent., and full 100 per cent. if the load is continued over half an hour. The restoration is effected by tipping the working parts outward, as shown in Fig. 3, until the liquid in the indicating tube runs up into the air bulb *A B*, Fig. 1, when on tipping it back the liquid runs down into the tube *L*, and the meter is ready again to indicate the maximum during the next predetermined period, generally a month or quarter. It is connected up simply in series with the ordinary integrating watt or ampere-hour meter, and indicates directly the number of kilowatt hours or ampere hours which should be charged for at the full rate, the balance of the kilowatt hour or ampere hour indication being charged for at a discount dependent on the wishes of the central station management. Thus, the greater the brief load of a given installation and the greater the reserve capacity of engines, dynamos, lines, etc., which the central station must maintain to carry these brief loads, but which increase the fixed charges of the system, the greater is the proportion of the consumer's load, which is paid for at the full rate.

FIG. 2.

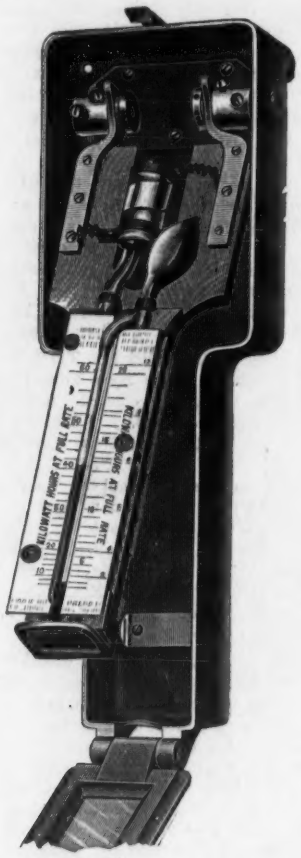


FIG. 3.

This system, as has been repeatedly pointed out by its designer, Mr. Arthur Wright, of Brighton, England, and many advocates on this side of the water, gives a very equitable method of charging. It encourages the use of current by the central station's best customers, namely, those who maintain a steady load, and charges those who use the current comparatively infrequently, and are, therefore, less desirable, the higher rates. The instrument is a most simple one, with no delicate working mechanical parts, and gives in service far less trouble than even the best of integrating motor meters.

NEWS OF THE WEEK

Financial Intelligence.

THE ANNUAL REPORT of the Third Avenue Railroad Company, New York, for the year ended October 31, shows the following results as compared with the previous year: Gross earnings $2,359,779, a decrease of $211,043; operating expenses $1,280,465, decrease $164,180; net earnings $1,079,334, decrease $46,860. After adding other incomes and deducting charges and dividends, the total remaining surplus is $210,405, a decrease of $47,926.

Special Correspondence.

NEW YORK NOTES.

THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS held its 129th meeting at 12 West Thirty-first Street on Wednesday evening last. Mr. Fred W. Carter, of London, England, read a paper on "The Design of Transformers."

MR. CHARLES H. KIRKLAND will represent in the metropolitan district the Bibber-White Company, of Boston, Mass., manufacturer and jobber of electrical merchandise. Mr. Kirkland, who is well known to the electrical fraternity in and around New York, will open offices at No. 129 Greenwich Street.

THE ANNUAL MEETING of the Telegraphers' Mutual Benefit Association was held in the Western Union Telegraph Building on the afternoon of November 16. The reports submitted by the president and secretary show the association to be in a prosperous condition. The officers of the last year were re-elected to serve during the ensuing year.

MR. H. J. MEDBERY, president and general manager of the Warren-Medbery Company, Sandy Hill, N. Y., has just returned home after a brief business trip to the metropolis. The New York office of the Warren-Medbery Company, by the way, has been removed from the sixth floor to room 101, eighth floor of the Taylor Building, 39 Cortlandt Street.

CONSUMMATION OF THE BROOKLYN ELECTRIC LIGHT DEAL.—The property and plant of the Edison Electric Illuminating Company, of Brooklyn, were on November 14 transferred to the Kings County Electric Light & Power Company, in accordance with the recent deal between the two concerns. The consolidation, it is stated, will result in some radical changes in the management and incidentally in the saving of $200,000 or more per annum in the operating expenses. It is stated that the Kings County Company will lower prices as rapidly as is feasible, with the idea of reaching the point of successful competition with gas.

A MEETING of the creditors of H. B. Coho & Co. was held November 18 at 143 Liberty Street, this city. About 75 per cent. of the creditors were present or represented. The liabilities were stated to be $60,000, and assets estimated at $40,000. A committee of five creditors was appointed to wind up the business, collect the outstanding accounts and divide the proceeds pro rata among the creditors. The committee consists of representatives of the Eddy Electric Manufacturing Company, the Oswego Boiler Works, the Marietta Manufacturing Company, the City Bank of Hartford and the Harrisburg Foundry & Machine Works. The business was started in 1884 by Mr. Herbert B. Coho, and the "Co." was George C. Hoffman.

NEW MEMBERS OF THE NEW YORK ELECTRICAL SOCIETY.—At the meeting of the New York Electrical Society on November 17 twenty-five new members were elected. Among them were the following named gentlemen: Augustus Treadwell, Jr., Electric Storage Battery Company, New York City; Bernhardt Hoffman, New York Telephone Company, New York; Frank R. Wainwright, Chesley Electric Company, Newark, N. J.; Thomas J. Fay, Electrical Engineer School of Correspondence, New York; J. E. Woodbridge, editor THE ELECTRICAL WORLD, New York; Charles E. Dustin, Excelsior Electric Company, Brooklyn; Henry B. Cutter, Philadelphia; Charles T. Child, electrical editor "Engineering Magazine," New York; Dr. Louis Duncan, New York; W. D. Weaver, editor "American Electrician," New York; A. E. Clifford, "American Electrician," New York; A. E. Stamm, Chesley Electric Company, Hoboken, N. J., and V. C. Gilpin, Cutter Electrical & Manufacturing Company, New York.

MR. W. D. WEAVER, who has just returned to his journalistic duties after several months' active service in the United States Navy as chief engineer of the United States refrigerating steamer "Glacier," was tendered a complimentary dinner by several of his professional contemporaries and friends on the evening of November 16. The dinner was given in a private dining room at the Engineers' Club, 374 Fifth Avenue, and was an extremely pleasant affair. Fifteen gentlemen sat down to the table, and after the wants of the inner man had been duly attended to Lieutenant Weaver related his experiences in Cuba, and made some interesting observations upon the war and its results. Many of the other gentlemen present made remarks complimentary of the guest. The dinner was entirely informal, and every one, knowing every one else present, felt quite at home, and the evening passed away very pleasantly indeed. Dr. Louis Duncan and Mr. E. C. Bernard, of Troy, N. Y., were among those present.

THE ANNUAL MEETING of the American Society of Mechanical Engineers will be held in this city at the society's parlors, 12 West Thirty-first Street, November 29 to December 2 next. The convention will open at 9 o'clock P. M. on November 29, when President C. W. Hunt will deliver his annual address. Among the papers to be read during the meetings will be the following: "Cooling Tower and Condenser Installation," by J. H. Vail; "Improvements in Steam Boilers," by W. B. Le Van; "Valve Gear of the Willans Engine," by John A. F. Svenson; "Variation of Belt Tensions with Power Transmitted," by W. S. Aldrich; "Calorific Power of Weathered Coal," by R. S. Hale; "Specific Heat of Superheated Steam," by R. C. Carpenter. Considerable attention will be paid to entertainments, etc. During the afternoons visits will be made to various points of engineering interest. On the afternoon of November 30 a visit will be made to the Duane Street station of the Edison Electric Illuminating Company. On the afternoon of December 1 an excursion will be made to the plant of the John Stephenson Company, Limited, at Elizabethport, N. J., which represents the most advanced practice in electrically driven tools. Other points of interest which will be visited will be the Stevens Institute, Columbia University, the power houses of the United Electric Light & Power Company and the Broadway cable line, and the eastern power house of the Brooklyn City Railway Company. At 9 o'clock on the evening of November 30 a reception and conversazione will be held at Sherry's, Forty-fourth Street and Fifth Avenue.

BUFFALO AND NIAGARA FALLS NOTES.

THE INCLINED RAILWAY that leads from Prospect Park, Niagara Falls, to the bottom of the gorge will be operated by electric power next year, instead of steam.

IT IS SAID that if the Canadian authorities oblige the power company to develop power on that side of the falls, and there is no call for it there it will be cabled across to this side. As this form of energy has been declared to be "raw material" it can be brought to the United States free of duty.

IT IS REPORTED that the Niagara Power Company has never received so many inquiries in regard to power as are coming in now. More orders for generators are to be placed at once. The State Reservation at Niagara, which has the right to use a certain amount of power from the power company, is now preparing to take the current.

THE CANADIAN GOVERNMENT is in doubt over the petition of the Niagara Falls Power Company for the exclusive right to develop power from the falls. It is thought that the plea of the company, that it is paying an annual rental of $25,000 for this privilege, will more than anything else finally secure the renewal of this exclusive privilege.

A CARPET FACTORY, to be run by power from the Niagara tunnel plant, is to be built at Echota, a short distance above the power house. The contracts are signed, but the details are not yet made public. There is also a move to establish a manufactory of electrical machinery at Niagara Falls. It will be a branch of one of the large companies.

THE EARNINGS of the Buffalo & Niagara Falls and Buffalo & Lockport trolley lines for the quarter ending September 30 are small, considering that the period covers the heavy summer travel season. The net earnings of the Niagara Falls line are $38,712.50, and net income $11,808.38. Of the Lockport line the net earnings are $7,428.21 and net income $1,898.17. The capital of the former is $1,000,000 and of the latter $1,250,000.

THE INCREASE IN THE LOAD ON THE NIAGARA-BUFFALO TRANSMISSION LINE.—On Friday, November 11, the power given to the transmission line leading from the Niagara Falls power plant to Buffalo was cut off from the rest of the plant feeding the local service and put on a special generator in order to give a higher voltage, the load having become such that the line drop necessitated this change.

A TROLLEY LINE is to be built from Buffalo to Rochester. It was at first reported that the line would parallel the New York Central's main line, but this is now denied, and it is said that the new road will originate at Niagara Falls. From this it is not difficult to infer that the Buffalo & Lockport road will be made the western end of the line, as it already covers a quarter of the distance. The projectors of the enterprise are very reticent over the matter.

THE STARTING OF THE BUFFALO GENERAL ELECTRIC COMPANY'S TRANSFORMER STATION.—The machinery of the new transformer station of the Buffalo General Electric Company was turned over for the first time on Saturday afternoon, November 19. But one of the small sets of this station had had current through it previous to this time. Both exciter sets and all six of the motor-driven arc light twin sets were brought up to speed, and with the sole exception of one of the exciters started off successfully, turned over in the right direction, and exhibited not the slightest sign of any mistake in the running of the large number of wires required in a motor-driven plant of this kind.

CHICAGO NOTES.

MR. R. E. INSKEEP, general manager of the Akron Electrical Manufacturing Company, Akron, Ohio, visited Chicago during the week on the business of his company. He arranged with Messrs. Meysenburg & Badt to represent the Akron Electrical Manufacturing Company in the Western territory.

AN ORDER directing the sale of the Metropolitan Elevated Railroad at an upset price of $6,000,000 has been entered by Judge Showalter in the United States Circuit Court. Twenty days are allowed for the redemption of the bonds and stock, and it is expected that the sale will take place in January. On January 20, 1897, the foreclosure was asked on the first mortgage for $15,000,000, dated August, 1892, the complainants being Adrian Iselin, Jr., and George G. Haven, trustees of the deed. Mr. Dickinson McAllister was appointed receiver.

"PRACTICAL NOTES ON ELECTRICAL MEASUREMENTS" was the title of a paper read by W. B. Hale before the Chicago Electrical Association on the evening of October 21 last. Mr. Hale pointed out the difference between ammeters and voltmeters, the former, he said, being a low-resistance voltmeter and a voltmeter being a high-resistance ammeter. He referred at length to the practical use of these instruments, and described the general method of measurement of resistances, both low and high, and battery testing, and concluded his paper with a description of the practical units of electrical measurement. The paper was very elementary in character, and was interesting no doubt to all those who had the pleasure of being present at the meeting.

ST. LOUIS NOTES.

BURIAL OF CITY WIRES.—The superintendent of fire-alarm and police telegraph has taken the first steps toward the burial of the city wires. He has turned over to the City Register for publication two advertisements relating to contracts, one for supplying the cables and connections, and the other for putting them into the conduits.

THE KINLOCH TELEPHONE COMPANY has announced that about 450 of its instruments in the downtown district are in working order. No books have as yet been furnished, and none of the officers will vouchsafe the time when the entire system will be in full operation. What service is now being given is during the day only and not at night.

THE OPENING of the long-distance telephone line between Kansas City and St. Louis was attended on the night of November 15 by Governor Stephens, who sat at one end of the line, at Tenth and Olive Streets, and delivered a brief congratulatory address to 300 members of the Commercial Club in Kansas City. The line is rapidly extending westward.

THE PLANT for lighting Webster Groves, a suburb of St. Louis, by electricity has been completed, and on November 14 128 new 16-cp incandescent lights were turned on for the first time. The lights are distributed over the city at places designated by the committee on public improvements. Old Orchard, Tuxedo and Webster Park are included in the lighted district. The Suburban Electric Light & Power Company is furnishing the power.

LINDELL CONSOLIDATION.—President Whitaker, of the Lindell Railway Company, is working hard on the plans for consolidating the several lines of the system granted by the Municipal Assembly. He hopes to have the details of the plan arranged by January 1, but is by no means positive he can complete the work by that time. Mr. Whitaker will not divulge any of the proposed details, but outside parties state that the capital stock of the consolidated lines will be $10,000,000. The new system embraces the several branches of the old Lindell Company, the Olive Street cable road and the Manchester and Laclede electric lines. There will be a total of 55 miles of tracks, with twenty transfer points.

A TELEPHONE TEST CASE.—On November 15 a foreman of construction for the Bell Telephone Company was arrested at the instance of the superintendent of the fire-alarm telegraph service. He was charged with interfering with the city's wires. He was tried and fined, but his case was appealed. The action of the authorities places the Bell Telephone Company in a peculiar position. If it proceeds to comply with the city ordinance, requiring the burial of its wires, its action would result in an absolute paralysis of the city's fire-alarm telegraph system. Should it fail to carry out the requirements of that same ordinance it would subject itself to a string of daily penalties that no corporation would care to burden itself with. The underground conduit ordinance requires the burial before January 1, 1899, of all overhead wires, except the trolley wires of the street railway companies.

CITY LIGHTING.—The committee on city lighting of the Board of Public Improvements will prepare another bill to present to the City Council providing for the contract for lighting the city during and after the year 1900. Fourteen bills prepared by the Board of Public Improvements have already been rejected by the Council. The instructions offered in the resolution presented to the Council at a meeting last week, instead of being a help in the preparation of a bill, tend to further complicate the situation. The committee finds that one of the bills embodying features suggested by the resolution was approved and became a law. Bids were advertised for, but the lighting companies refused to bid, giving as an excuse that the ordinance was invalid. The defeat of the Julian law will allow the board to prepare a bill allowing the city to do private lighting in the event of the city conducting its own lighting plant. Under the Julian law this would not have been permitted.

PACIFIC COAST NOTES.

CHEHALIS, WASH., will soon have an independent telephone system in operation.

THE CITY COUNCIL of The Dalles, Ore., recently passed, over the mayor's veto, an ordinance which authorized the lighting of the streets by electricity. The local lighting company will have to install additional generators in order to furnish the required service.

THE EXTENSIVE electro-plating plant of the Southern Pacific Railroad Company was destroyed in the fire which burned several buildings at the Sacramento shops, where 2200 men are employed. A very complete alternating electric-power system is in operation at the shops. The burned buildings will be rebuilt as soon as possible.

THE ASTORIA STREET RAILWAY COMPANY, Astoria, Ore., recently gave an option on its rolling stock and other property to F. D. Kuettner, of the Astoria & Columbia River Railway Company. The persons interested have petitioned for a street-car franchise to run seventy-five years, and also to supply electricity and steam for a variety of purposes.

THE PEOPLE'S MUTUAL TELEPHONE COMPANY, San Francisco, has been again granted a year's extension of time in which to comply with the conditions of its franchises. President Crittenden promised that the system would be in operation within six months, although very little work has yet been done. He stated, also, that he had let contracts for supplies aggregating in value $176,500.

THE BLUE LAKES WATER COMPANY is pushing the construction of its pole line to Stockton, Cal., the transmission distance being 38 miles. The company expects to be ready to transmit its surplus of current generated at Blue Lakes City to Stockton by January 1 next. The voltage on the line will be 38,000, and there are no great engineering difficulties to be overcome. Pure aluminum wire will be used for transmission purposes. Stanley two-phase generators are in use.

CANADIAN NOTES.

THE ROAD COMMITTEE of the city of Montreal will ask the City Council to take steps to have all electric wires, except trolley wires, placed underground.

THE ARTHABASKAVILLE RAILWAY COMPANY, of Arthabaskaville, in the province of Quebec, is asking for incorporation to construct a steam or electric railway from Dudswell to Maddington Falls.

THE TOWN of Barrie, Ont., is negotiating with the Barrie Electric Light Company for the purchase of its electric plant. The sum of $35,000 has been placed in the hands of the Town Council to purchase a municipal plant, and the question is whether the existing plant will be taken over or an entirely new one installed.

MR. GEORGE E. SLEEMAN, of Ottawa, has a car fender on exhibition which he claims is superior to many in use at present. The fender is as wide as an ordinary car and has a cushion of strips of wood attached to an iron frame. In front of the frame is a strip of wood which acts as a guard, and when touched it causes the fender to fall to the rails where it cannot help picking up anything it runs against. It is easily attached and detached. The fender has been successfully used in Guelph, Ont.

A PROPOSITION has been made to the city of Toronto, on behalf of the Anglo-American Electric & Supply Company, for the supply of electrical energy to the city. In a letter to the Council the statement is made that the company proposes to put in a 10,000-hp plant at a cost of about $1,000,000. Tenders were also opened last week for the supply of an electric plant for civic and commercial lighting and power for the city. The tenders were found to be incomplete, and as a result the city engineer has recommended that none of them be accepted, it being impossible, owing to the small number of tenders received, to arrive at even an approximate estimate of the cost of the plant.

ENGLISH NOTES.

A NEW INFLUENCE MACHINE.—At a meeting of the Physical Society on October 28 a new type of influence machine was described by Mr. W. R. Pidgeon. As in the Wimshurst, the machine consists of a pair of glass discs rotating in opposite directions on a spindle. They are partially covered on one face with narrow radial sectors of tin-foil, each provided with a small brass knob. This face of the disc, including its sectors, is coated with insulating wax in such a way that only the knobs project through the wax. Two earthing brushes pass through the insulating fixed inductors and support them, these inductors being kept charged by exploring points connected to each and placed so as to collect electricity from the revolving discs. By means of brushes the sectors on each of the discs are successively earthed at the moment they pass the fixed inductors, i. e., when their capacity is a maximum, and they are made to deliver up their charge to the main collective brushes when they are electrically farthest from the inductors, i. e., when their capacity is a minimum. The thick coating of wax restricts leakage to the small area of the connecting rods, so that the effects of dirt and moisture, so troublesome in the usual types of influence machines, are considerably reduced.

OPENING OF THE FOLKESTONE ELECTRICITY SUPPLY WORKS.—The Folkestone electricity supply works were formally opened on November 2 by the mayor of the town. The station is but a small one, its present capacity being only about 300 kilowatts, but it embodies some of the best features of English electrical engineering practice. The area of supply is very compact, but unfortunately it was found impossible to acquire a site for the central station in the centre of the town, so that the station which has been built lies about a mile from the centre of the supply area. It has, however, the advantage of being close to a railway station, and has a private siding from which coal is delivered straight into the bunkers. The boilers are of the well-known Davy-Paxman "Economic" type, 14 feet long by 8 feet diameter, each being capable of evaporating 6000 pounds of water per hour by working at a pressure of 150 pounds. The steam pipes are arranged on the usual ring main system, and are of 6-inch steel, with copper bends, with 5-inch steel connections to the boiler and 2½-inch and 3½-inch copper connections to the engines. Geipel steam traps are used at the ends of the ring to drain the pipes. Three Peache single-acting three-crank type of engine are directly coupled to Parker dynamos. The latter are of the bipolar type, two having an output of 160 amperes and the third 380 amperes, all designed to work at from 420 to 460 volts. The distribution is on the three-wire system at 420 volts across the outers, and balancing is insured by a battery connected across the mains, and a booster set. Another battery is to be installed in the town at a later date. The mains are of the Callender Construction Company's type, insulated with impregnated jute, lead covered and armored, and laid directly in the ground. There are a number of arcs on the network, including street lighting in some parts of the town. These lamps are all connected eight in series across the 420-volt mains.

INSTITUTION OF CIVIL ENGINEERS.—Mr. W. H. Preece, the newly elected president of the Institution of Civil Engineers, delivered his inaugural address on November 1. The position of president of this institution is one of the very highest honors, and Mr. Preece is to be congratulated on being the first electrical engineer who has been appointed to fill it. Naturally the major portion of Mr. Preece's address was devoted to the subjects of telegraphy and telephony. Among other interesting figures he cited the following are

specially worthy of note, representing the extent of the present system of telegraphs owned by this country:

	Miles of Wire.
General Post Office and its licensees	435,000
Railway companies	105,000
India and colonies	387,966
Submarine cables	183,400
	1,111,366

Referring to the scarcity of gutta-percha the speaker noted the fact that lead-covered paper cables were now coming very much into use. A 76-wire cable insulated with paper is, as I have mentioned in a previous letter, being made between London and Birmingham for telegraphic purposes. The cable companies are, acording to Mr. Preece, also contemplating leading their long cables from Cornwall to London, so as to be free from weather troubles, and it is quite possible that paper will be the dielectric used to surround the conductors. Referring to wireless telegraphy Mr. Preece stated that visions of dispensing with wires altogether had been fostered by the popularity of Marconi's system. But wireless telegraphy was as old as telegraphy itself, and a practical system of his own was now in actual use by the Post Office and War departments. "Sensational experiments for 'booming' a new financial enterprise, were not," he said, "processes which commended themselves to this institution. We want practical work and engineering progress." Coming to telephony the president reminded his audience that it was now possible to speak between many important towns in England and France, and that it was theoretically possible to talk with every capital in Europe. The Post Office Department is now considering the submersion of special telephone cables to Belgium, Holland and Germany. The following expression of opinion as to the ownership of the telephone system, coming from the chief engineer of the Post Office, has particular significance at the present moment: "The progress of the use of the telephone in Great Britain has been checked by financial complications. It fell into the hands of the company promoter. It has remained the shuttlecock of the Stock Exchange. It is the function of the Postmaster-General to work for the public every system of intercommunication of thought which affects the interests of the whole nation. Telephony is an imperial business, like the post and telegraph. It ought to be in the hands of the state. The public and the press have frequently kicked violently against the present regime. Committees of Parliament have sat and deliberated upon the question. The report of the last committee is now under consideration. 'Quidquid delirant reges, plectuntur Achivi.' Two causes exist to impede this desirable absorption, the fear of being 'done' by watered and inflated capital, and the assumed bad bargain made in absorbing the telegraphs in 1869. The former is a mere bugbear. The public does not want to purchase stock. It wants to acquire a plant and business which can be easily and fairly valued. The latter is a gross fallacy." Up to the end of 1898 the number of telephones in use by the National Telephone Company was 133,498. Those in use by the General Post Office number only 9588; and railway companies owning 8933 instruments brought the total to 152,019. An interesting table was also given showing the extent to which the various systems of electric signaling were used on the railways of the United Kingdom.

French Notes.

A SERIES of trials in practical transportation by large automobiles was begun on October 6 at Versailles, under the name of "The Competition for Heavy-Weights." For six days the heavy cavalry of steam, electricity and petroleum marched and counter-marched, accompanied by much noise, up and down the quiet streets of Versailles, and roundabout the neighboring country. This makes the second year that this competitive trial has been run off with success. There were eleven manufacturers represented by eighteen vehicles, two of which were of foreign make. The preceding year there were but fifteen vehicles, and all were French.

ELECTRIC TRAMWAYS.—An electric street railway is being built at Amiens. Separate gangs of workmen are pushing forward both the track and the overhead construction. There are now electric roads in many towns, Boulogne, Roubaix, Tourcoing, Châlons, Havre and Rouen, all towns in the same district, are provided with them. There are several systems in use, but the overhead trolley is the leading one. The Amiens municipality adopted the overhead trolley after an ocular demonstration of its advantages. They sent a committee of Municipality Councillors to examine the tramway system of Rouen. These gentlemen returned the next day very much pleased with their visit. At Lille, where the problem is to change over the existing car lines to the electric systems, two forms will be used. In the heart of the city some underground system is to be used, while in the suburbs it will be the overhead trolley. There was some thought of using an underground system in the principal streets of Amiens, where traffic is very heavy, but the Municipal Council decided against it.

THE HEILMAN COMPANY.—MM. Jean Jacques Heilman and Désiré Truchon have formed a company in Paris, to be known as the "Compagnie Heilman," and which is to work under the patents of M. J. J. Heilman on traction and navigation. The intentions of the company are set forth as follows: 1. To carry on business in France, the colonies or in countries under French protection in all forms of mechanical applications to traction and transmission of power, making use of the Heilman systems and others as well. To build, sell, or deal in any way possible in electric locomotives, motors and other electric or mechanical or heat machinery which relates to traction or transportation of any kind. 2. To engage in the transportation of passengers and freight by land or by water, making use of any form of mechanical or electrical propulsion. 3. The promotion of enterprises and the soliciting of franchises with or without subsidies from towns, provinces or the state for the creation of companies to undertake the transportation of passengers and freight. 4. The construction or acquisition of manufacturing establishments in any way connected with the above mentioned enterprises; the acquisition or renting of real estate, whether buildings or otherwise; the erection of any buildings or the acquisition of all accessories or furniture needed. 5. The participation of this company, either directly or indirectly, whether in France or in foreign countries, in transportation enterprises, and in all commercial, industrial or financial operations which may be in any way connected with them, either through the creation of new companies or the enlargement of or amalgamation with existing ones. The provisional offices of the company are at No. 38 Rue de Laborde, Paris.

General News.

New Incorporations.

THE CARO LIGHT & POWER COMPANY, Caro, Mich., has been incorporated with a capital stock of $25,000.

THE ROCKY FORD ELECTRIC LIGHT COMPANY has been incorporated at Pueblo, Col., with a capital stock of $15,000.

THE UNITED TRACTION COMPANY, Chicago, Ill., has been formed by A. B. Wilson, A. E. Meanor and L. J. Bohan, with a capital stock of $500,000.

THE CAMDEN, DUNKIRK & ALBANY ELECTRIC TRACTION COMPANY, of Dunkirk, Ind., has been incorporated with a capital stock of $10,000.

THE CINCINNATI, LAWRENCEBURG & AURORA ELECTRIC STREET RAILWAY COMPANY, Aurora, Ind., has been incorporated with a capital stock of $10,000.

THE HARPER'S FERRY ELECTRIC LIGHT & POWER COMPANY is the title of a new concern incorporated at Harper's Ferry, W. Va., with a capital stock of $15,000.

THE MUTUAL ELECTRIC COMPANY has been incorporated at Waco, Tex., by W. W. Seley, S. W. Sladen, I. A. Goldstein and L. Migel. The capital stock of the company is $10,000.

THE GREGORY ELECTRIC COMPANY, Chicago, Ill., has been incorporated with a capital stock of $100,000. The incorporators are Charles E. Gregory, George A. Fargher and George Wadsworth.

THE EL PORTE ZUELO LIGHT & POWER COMPANY has been incorporated in Chicago, Ill., with a capital stock of $500,000. The incorporators are C. D. Crandall, William H. Carpenter and W. R. Patterson.

THE MITCHELL-PARSON ELECTRIC COMPANY, Portland, Me., has been incorporated with a capital stock of $150,000. The incorporators are George A. Copeland, Revere, Mass., and William E. Pearson, Winthrop, Mass.

THE NORTHERN MINNESOTA TELEPHONE COMPANY, Park Rapids, Minn., has been incorporated with a capital stock of $10,000. Among the incorporators are Charles Moody, F. A. Vanderpool, of Park Rapids, and others.

THE SANDS ELECTRIC COMPANY, Cleveland, Ohio, has been incorporated with a capital stock of $10,000, to manufacture all kinds of electrical appliances. Among those interested are L. Sands, E. Velhagen and F. B. Sheels.

THE ABBOTT ELECTRIC & MANUFACTURING COMPANY, Cleveland, Ohio, has been formed for the purpose of manufacturing electrical and mechanical devices. The incorporators are H. H. Hammond, H. I. Wickes, William A. Marbach, S. Abbott and C. B. Abbott. Capital stock, $15,000.

The Telegraph and Telephone.

EAST PROVIDENCE, R. I.—The East Providence Telephone Company has been incorporated with a capital stock of $25,000.

WINCHESTER, KY.—The East Tennessee Telephone Company has been granted a franchise to maintain a telephone system in this place.

MONTGOMERY, ALA.—A franchise to establish and maintain a telephone system in this place has been granted to W. F. Vandiver, F. M. Billings and others.

MONTPELIER, VT.—The Montpelier Telephone Company has been incorporated with a capital stock of $15,000. It proposes to build and maintain lines between villages in Williams and Fulton counties.

STAMFORD, CONN.—The telephone line from Walton to Masonville, Deposit, Cannonsville, Trout Creek and points between has been taken down. Since the putting in of the local exchanges the line does not pay.

ATLANTA, GA.—Mr. E. C. Spaulding, of Atlanta, has been appointed temporary receiver by Judge Emory Speer for the Augusta Telephone & Electric Company. The petition was filed by Marion Erwin, attorney for Thomas & Post, New York.

KANSAS CITY, MO.—The Missouri & Kansas Telephone Company has asked the Board of Public Works for permission to construct conduits for its wires along certain streets in the city. Action on the petition will be taken at the next meeting of the board.

WASHINGTON, D. C.—A final settlement has been effected between the Post Office Department and the Western Union Telegraph Company on money due the company on account of rates fixed by Postmaster-General Wanamaker. The claims of the company, aggregating $260,000, have been paid.

CLOQUET, MINN.—The Duluth Telephone Company, which has obtained of the Village Council a franchise for constructing a long-distance telephone line from this place to Duluth, has bought the O'Brien line between Cloquet and Carlton. The line will be completed at once through to Duluth via Carlton.

DAVID CITY, NEB.—The Nebraska Telephone Company has the Seward and Columbus line completed to the junction with the York and David City line, and has only to put on the extra wires from the junction to town to be

in connection with Seward and points south. The line north to Bellwood and Columbus will be completed in a few days.

BUFFALO, N. Y.—Threatened litigation has caused the Empire State Telephone Company to abandon its project of building lines in sections of Monroe and Ontario counties. Farmers combined to ask the company to pay big sums for the privilege of setting poles. Now that the project has been declared off there is a howl from the ones who caused the trouble.

DES MOINES, IA.—A meeting of the Iowa Telephone Association was held recently in Des Moines for the purpose of agreeing upon tolls and the proper division thereof between the different independent lines in the association. Among the different lines represented at the meeting were the Mutual Company, of Des Moines, by J. W. Hill; the Southwestern Telephone Company and Clearfield & Mt. Ayr Company, by D. M. Smith; the Perry Telephone Company, by G. M. Brady; the Jefferson Telephone Company and the Boone-Marshalltown Company, by C. E. Wells, and the Central Telephone line by W. Brandt. The companies now in the association have lines reaching 184 towns in this State. They have just opened connections with Dayton. Harcourt and Gowrie with metallic circuit lines. Among the different improvements being made by the independent companies is a line by the Central Telephone Company, of which J. W. Hill, of Des Moines, is president. The company will complete the construction of a line to the southwest, reaching Oskaloosa and Ottumwa before December 1. In Fort Dodge a new metallic circuit line is being constructed with which all independent lines will have connections. In addition to this improvement there will be built from Fort Dodge to Sioux City a metallic circuit line in connection with the independent lines. The Boone-Marshalltown line, connecting Boone, Marshalltown and Des Moines, was recently completed. The old grounded line has been abolished and the metallic circuit substituted.

ELECTRIC LIGHT AND POWER.

EMMETSBURG, IA.—The citizens of this place have voted to establish an electric light plant.

DECATUR, ALA.—Mr. R. D. Smith is interested in the organization of a company here to build an electric light plant.

CARTHAGE, MO.—An election will be held to vote on the proposition to issue $25,000 bonds for the purpose of constructing an electric light plant.

SARCOXIE, MO.—It is proposed to establish an electric light plant in this place, and the Sarcoxie Electric Company has been organized for the purpose.

WYNNE, ARK.—There is talk of establishing an electric light plant in this place. Mr. W. M. Kennedy is in a position to give further information on the subject.

BOSTON, MASS.—The Massachusetts Electric Freight Company has applied to the Legislature for a charter. It asks for authority to make contracts with street railway lines to carry freight.

MILLEDGEVILLE, GA.—There is some talk of building a municipal electric light plant in this place, with a capacity of 50 arc and 1000 incandescent lights. Mayor H. H. Horne can give further information on the subject.

SEABRIGHT, N. J.—The Seabright Electric Light Company will rebuild its plant which was destroyed by fire several years ago. The company has bought a lot, adjoining the Shrewsbury River, and will begin the erection of a building.

SAVANNAH, GA.—The Edison Electric Illuminating Company, which was recently organized here by New York and Savannah gentlemen, is applying to the City Council for a franchise to operate an electric lighting plant. The company has a capital of $100,000.

SENECA FALLS, N. Y.—The Seneca Electric Light & Power Company, embracing the plants at this place and Waterloo, has been placed in the hands of a receiver. This action was brought about by the Old Colony Trust Company, of Boston, as trustee of the company's bonds. H. H. Crowell, of Syracuse, has been appointed receiver.

GRAND RAPIDS, MICH.—The Newaygo Transmission Company has been organized by local capitalists, with $15,000 capital, to develop the water power at Newaygo, 30 miles north of here, and to transmit electric power to this city. The company has been given a franchise to erect poles and string wires in this city. A. C. Sekell and Charles F. Pike are the chief promoters of the enterprise.

NEW YORK CITY.—Recent changes in the directorate and management of the Block Lighting & Power Company gave rise a few days ago to a rumor that the concern, which holds a perpetual franchise for the manufacture and sale of electricity for lighting and power purposes, had been sold to the Metropolitan Street Railway Company. This rumor, however, was denied by Edward P. Doyle, ex-president of the Block Company.

FORT WORTH, TEX.—The report of the Fort Worth City Electric Light Works for the year ended March 21, 1898, shows that the cost of each 30-cp incandescent lamp per year, with interest, was $8.06, without interest, $5.27; cost of each 1200-cp arc lamp per year, with interest, $64.48; without interest, $42.10. There are 402 30-cp incandescent lamps and 68 arc lamps in use in the city. The report states that the small boy burdens the department with an expense on account of breakage of lamps, for which there is no feasible remedy.

TRENTON, N. J.—On November 15 Mr. Thomas C. Barr, of Orange, and Col. A. R. Kuser, of Trenton, purchased the stock and franchises of the Trenton Electric Light & Power Company, paying therefor, it is stated, $416,000. It is understood that the consolidation of the electric light company with the Trenton Street Railway Company and the Delaware River Improvement Company will be effected. The latter concern owns a water-power franchise at Merrisville, Pa., just across the river from Trenton, and proposes to dam the Delaware River for the purpose of obtaining water power for the operation of the electric light and street railway plants. It is stated also that one of the projects in view is the building of an electric railway to Philadelphia.

THE ELECTRIC RAILWAY.

EVANSVILLE, IND.—Dayton capitalists have petitioned for a franchise to build an electric railway from Evansville to Rockport, Tell City and Cannelton.

ELLICOTT CITY, MD.—The new electric railroad between Baltimore and Ellicott City is nearing completion, one track having been finished almost to the terminus here.

WHEELING, W. VA.—The Wheeling Street Railway Company is considering the question of increasing its capital stock, and may decide upon issuing bonds to make improvements in its system.

NEWPORT NEWS, VA.—The Peninsula Railway Company, composed of W. A. Post, Frank Lee and A. L. Parker and others, has applied to the Council for a franchise for the construction of a new street railway in this city.

DES MOINES, IA.—The Des Moines Edison Electric Light Company has increased its capital stock from $130,000 to $450,000. A new building is being constructed at the water-power plant at Centre Street, which will be equipped with water wheels.

LIMA, N. Y.—The employees of the Lima & Honeoye Falls Railroad are on strike, and the road is tied up. The trouble has been pending for some time. The cause, it is claimed, is the inability of the employees to get what is owing them.

HAVANA, CUBA.—The sale of the Ferro-carril Urbanos system is announced to an English stock company for $1,600,000. The system covers 25 miles of road. The entire line will be rebuilt and the motive power will be changed to electricity.

PORT CHESTER, N. Y.—The Port Chester Street Railway Company has made applications for the extension of its road from the present terminus, in Rye village, to Mamaroneck, to connect with the Mamaroneck, White Plains & Tarrytown Railroad.

CHICAGO, ILL.—The report of the receiver of the Calumet Electric Railway covering the period from May 1, 1897, to August 31, 1898, shows total receipts of $503,475; disbursements $492,038; receipts from operations, $281,786; cost of operation and expenses, $279,409.

DALLAS, TEX.—The Dallas Rapid Transit Electric Street Railway property, approximating 11 miles of track, a power house, rolling stock and other assets, were recently sold at trustees' sale. The purchaser was a man named Thayer from Boston, and the property went to him at $35,000.

BOSTON, MASS.—The directors of the Newport & Fall River Street Railway Company have declared a semi-annual dividend of 3 per cent., payable on January 1 next. This is the first dividend declared by the company. The road has been in operation since June 9 and up to November 1 its net earnings amounted to $20,897.

JACKSON, MISS.—There was general rejoicing in Jackson when the work of tearing up the old horse-car tracks was begun and the public realized that actual work on an electric line begins at once. General Garnes and other Tennessee capitalists are behind the enterprise, and will spend more than $100,000 on the car line and lighting system.

LEXINGTON, KY.—A company is being formed in this city to build an electric railway between Lexington and Richmond, Ky., a distance of 22 miles. The principal promoters are W. J. Loughridge, vice-president of the Electric Street Railroad Company, and Dr. Bennett, president of the National Exchange Bank. The road will cost $125,000. It will cross the Kentucky River at Clay's Ferry.

LYNCHBURG, VA.—The Lynchburg & Rivermont Street Railway Company will extend its present line from the city post office to the city park, a distance of about 1⅜ miles. Girder rails will be used on the paved streets and T rails on the unpaved streets. Track and overhead material will be required and perhaps two additional cars will be purchased. It is the intention to have the line ready for business early next year.

HOUGHTON, MICH.—The Village Council has granted a street railway franchise to William H. Taylor, of New York City, on condition that he secure franchises from other towns in this vicinity so as to complete a belt line connecting various places in the county. The proposed line will be 20 miles in length, and the only obstacle in the way of its building is said to be the objection of the Calumet & Hecla Company to allow the electric railway to cross its property.

OWOSSO, MICH.—Eastern capitalists and local owners of the road and power plant of the Owosso & Corunna Traction Company are planning to extend their electric lines running west of Detroit to Pontiac and Sylvan road. Grand Rapids and Chicago capitalists are also endeavoring to secure the property to construct lines through to Grand Rapids and Lansing. This will make Owosso the centre of all the electric roads in this part of the State. The capital interested is $400,000.

GALVESTON, TEX.—The United States Mortgage & Trust Company, of New York, has filed in the United States Circuit Court a suit against the Galveston City Railroad Company and the Guaranty Trust Company, of New York. The plea is for the foreclosure of the second mortgage, $75,000, made second only to the first mortgage, and the amount due, ascertained and determined, that in default of the payment of this sum within the time limited by the court it may decree that the railroad company and the city and all persons claiming an interest in the property be barred.

BROOKLYN, N. Y.—Public meetings are being held in this city remonstrating against the use by the Nassau Railroad Company of summer cars fitted up for winter use. These cars are provided with side doors, and in order to collect fares it is necessary for the conductor to open the door, thus letting in cold air and causing draughts, which the passengers protest against very strongly. The Brooklyn Heights Company is making capital out of the popular dissatisfaction against the Nassau Company's cars, and is calling attention to its own new and handsomely fitted up cars.

HAGERSTOWN, MD.—Plans for the electric railway over the Blue Ridge Mountains, in which Pennsylvania and Maryland capitalists are interested, are being perfected. The directors of the Blue Ridge Electric Railway Company

have selected a committee to decide upon the route. It is stated that the plan most likely to be adopted will connect Penmar and Blue Mountain House, and then swing over to Blue Ridge Summit, Monterey, Buena Vista and back to Penmar. From the latter point the line will extend to Waynesboro, Pa., and other points in the Cumberland Valley, and may also be extended to Gettysburg.

BALTIMORE, MD.—A syndicate of Baltimoreans, of which Messrs. Middendorf, Oliver & Co. are the representatives, with a capital stock of $300,000, has purchased bonds of the Atlanta Railway Company to the same amount. It is the purpose of the syndicate to control the road, developing it into one of the most efficient and best paying street railways in the city. The road has secured 10 miles of additional franchise, under which will be built a line to Grant Park, the city water works and West End. The total trackage of the road when complete will be 26 miles. The bonds of the new company amount to $500,000. The capital stock is $1,000,000.

KANSAS CITY, MO.—A franchise has been granted to the Jackson County Electric Railway Company to build a double-track line from the city limits to Dodson and Swope Park, a distance of between 5 and 6 miles. The incorporators of the company are F. W. Sears, B. F. Burd, W. H. Brown, Dr. C. McDonald and Henry Smith. It is stated that the company is identical with the Missouri Electric Railway Company, which was incorporated about a month ago by the same gentlemen, and which will operate the city end of the line. The city company's capital stock is $500,000 and the county company's stock $100,000. A power house will be erected at Bush Creek and Prospect Avenue at a cost of about $40,000.

NEW BRITAIN, CONN.—According to the returns of the Central Railway & Electric Company for the nine months ending June, 30, 1898, the gross earnings were $116,192.88; operating expenses, $79,210.65; net earnings, $36,982.23; no dividends were paid. Miles run, 338,403; passengers carried, 1,434,105; number of employees, 83. The returns of the Bristol & Plainville Tramway Company show gross earnings of $44,383; operating expenses, $33,005.80; net earnings, $11,377.81; dividends, $3000; miles run, 145,629; passengers carried, 543,032; number of employees, 30. The returns of the Hartford Street Railway Company show gross earnings, $438,069.12; operating expenses, $303,095.95; net earnings, $134,973.20; dividends, $21,000; interest, $77,938.72; taxes paid, $24,177.93; miles run, 2,228,935; passengers carried, 8,886,229; number of employees, 530.

SYRACUSE, N. Y.—About three months ago there was a forty-eight-hour tie-up of the lines of the Rapid Transit Street Railway Company, of this city. A compromise was effected by the State Board of Mediation and Arbitration, but dissatisfaction on the part of the men was evidently not entirely removed. On November 17 a general strike of the conductors and motormen was ordered by the president of the union. It is stated that the object of the present trouble is to secure a recognition of the union, which was one of the points yielded by the men at the time of the settlement of the last trouble. The employees, however, claim that the present difficulty is brought about through the unwarranted discharge of employees. There are 230 members of the union, and the lines involved comprise practically all the street railways inside the city. Very few of the employees obeyed the order to strike, and the service was not interrupted to any great extent, new men being put in the strikers' places.

ROCKLAND, MASS.—A plan for the amalgamation of all the street-car lines in southeastern Massachusetts is under way. The leaders in the project are Pepper and Register, owners of the Hingham street railway line. The acquisition of the Brockton, Bridgewater & Whitman Street Railway is only a link in the chain which will ultimately lead up to the control of the entire system of street railways in this section by the combination. In pursuance of a policy of expansion, which has been quietly developed, the promoters of the project have acquired a controlling interest in the Rockland and Arlington street railways. The syndicate has now control of a system of street railways from Nantasket Beach to Bridgewater, and the question of its control of the Hanover Street Railway is only a question of a short time.

Directory of Scientific Societies, Associations, Etc., and Meetings of the Same.

THE NEW YORK ELECTRICAL SOCIETY.—President, Gano S. Dunn; secretary, George H. Guy, 120 Liberty Street, New York.

HENRY ELECTRICAL SOCIETY meets every other Friday evening between October and May. Headquarters, 115 West Twenty-eighth Street, New York City.

THE MARITIME ELECTRICAL ASSOCIATION.—President, F. A. Bowman, of New Glasgow, N. S.; secretary, J. H. Winfield, New Glasgow, N. S. Last meeting, Halifax, N. S., September 27-28, 1898.

NATIONAL ELECTRIC LIGHT ASSOCIATION.—President, A. M. Young, Waterbury, Conn.; secretary, George F. Porter, 203 Broadway, New York. Next meeting, New York, May or June, 1899.

THE KANSAS GAS, WATER & ELECTRIC LIGHT ASSOCIATION.—Organized at Topeka, September 26, 1898. President, L. F. Palmer, Leavenworth; secretary and treasurer, J. H. Foley, Leavenworth.

STREET RAILWAY ASSOCIATION OF THE STATE OF NEW YORK.—President, G. Tracy Rogers, Binghamton, N. Y. Secretary, Henry A. Robinson, New York City. Next meeting, Ithaca, N. Y., September 12 and 13, 1899.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, New York.—President, Dr. A. E. Kennelly; secretary, Ralph W. Pope, 26 Cortlandt Street, New York. Meeting, fourth Wednesday of each month, from September 1 to June 1.

INDEPENDENT TELEPHONE ASSOCIATION OF THE UNITED STATES.—President, Judge James M. Thomas, Chillicothe, Ohio; secretary, W. J. Vesey, Fort Wayne, Ind. Next meeting, June, 1899. Place to be named hereafter.

THE BROOKLYN INSTITUTE OF ARTS AND SCIENCES, Brooklyn, N. Y. Henry T. Weed, secretary. Future meetings: December 2, lecture by Prof. William E. Geyer, Stevens Institute; January 6, lecture on "The Electro-Metallurgy of Copper," by John B. F. Hereschoff; February 3, lecture and experimental demonstrations by Prof. M. I. Pupin; March 3, illustrated lecture on "Electricity in the Navy," by Captain Zalinski, U. S. N.; April 7, lecture on "Cable Telegraphy," by A. E. Kennelly; May 5, lecture by Prof. William A. Anthony.

CHICAGO ELECTRICAL ASSOCIATION.—Meetings, first and third Friday of each month, from October 1 to June 1; J. R. Cravath, secretary, Monadnock Block, Chicago, Ill. Future meetings and papers for the season of 1898-99: "The Development of the Motorcycle," by F. B. Rae; December 2, "Practical Points in Street Railway Engineering," by W. A. Harding; December 16, "Wireless Telegraphy," by Arthur V. Abbott; January 6, 1899, "Telephone Engineering—Some Problems Solved and Unsolved," by S. G. McMeen; January 20, "Observations on Ventilating Fans," Gerard Swope.

FRANKLIN INSTITUTE (Electrical Section), Philadelphia, Pa.—Secretary, Wm. H. Wahl. Programme of lectures for the season 1898-99: November 22, "Thermo-electricity," by Mr. C. J. Reed, and "Electric Elevators," by Mr. Wm. Baxter, Jr.; December 13, "The Kite As an Instrument in Meteorological Research," by Prof. Charles F. Marvin, of the United States Weather Bureau, and "Standards of Light for Electric Light Photometry," by Prof. A. J. Rowland; January 24, 1899, "The Practical Application of the Electric Motor to Printing Press Machinery," by W. H. Tapley; February 14, "The Electric Inspection of Street Car Equipments," by Mr. A. B. Herrick; February 28, "Some of the Larger Transportation Problems in Cities," by E. E. Higgins; March 28, "Water Power Electric Plants in the United States," by Mr. B. C. Washington, Jr.; April 25, "Design of Electromagnetic Mechanism, with Especial Reference to High Frequency Telegraphic Receivers," by Prof. Reginald A. Fessenden; May 23, "Electrical Clocks, Historically Considered; with a description of the Most Successful Applications of Electricity to Clocks and the Uniform Distribution of Time," by Mr. James Hamblett. On February 10 Mr. T. Commerford Martin will deliver a lecture under the joint patronage of the institute and the Central Branch of the Y. M. C. A. on the subject of "Electric Power Transmission."

Legal Notes.

MUNICIPAL REGULATION.—An ordinance requiring a street railroad charging 5-cent fares to sell six tickets for 25 cents, or 25 tickets for $1 is unreasonable, when the road is only making yearly net earnings of 3.3 per cent. to 4.5 per cent. on its bona fide investment and paying 5 per cent. interest on its bonds. Such an ordinance is void, under the fourteenth amendment, as depriving the company of its property without due process of law. Milwaukee Electric Railway Company v. City of Milwaukee; U. S. Circuit Court (Wis.), 1898.

SPEED OF ELECTRIC CARS.—While electric cars at street crossings must so regulate their speed and give such warning of their approach that footmen using ordinary care may cross it safely, yet the rule between crossings is different, and footmen must be aware that cars between crossings run at a high rate of speed and are not under control, and cannot be stopped instantly, and the motorman need not apprehend that a footman between crossings will put himself on the track without first observing whether a car is approaching. Bethel v. Cincinnati Street Railway Company, Ohio Circuit Court, 1898.

Personal Notes.

PROF. W. M. STINE is now at the head of the department of engineering, Swarthmore College, Swarthmore, Pa.

MR. CHARLES E. BIBBER, of the Bibber-White Company, Boston, Mass., was in New York during the past week.

MR. R. E. INSKEEP, general manager of the Akron Electrical Manufacturing Company, Akron, Ohio, was in New York on business during the week.

MR. JOHN A. SEELY, of the firm of Belden & Seely, electric and steam railroad contractors, Syracuse, N. Y., is now located in that city. His address is 601 Granger Block, Syracuse, N. Y.

Obituary Note.

MR. JOHN W. KEELY, the inventor of the so-called Keely motor, died at his home in Philadelphia on November 18, from pneumonia. Mr. Keely was sixty-one years of age, and was a native of the city in which he died. His motor, which became so much talked about all over the world, was first exhibited to a number of capitalists and scientists on November 10, 1874. These gentlemen advanced $100,000 to enable the inventor to perfect his discovery and apply the principle. Since that time large sums of money have been expended on experiments without any practical public results. It is not yet known whether the secret died with the inventor or not. In 1888 he was confined in jail for a time for contempt of court in refusing to disclose the secret.

Trade and Industrial Notes.

MICA WASHERS for arc lamp repairs, made by Mr. A. O. Schoonmaker, 158 William Street, New York, are in good demand from lighting stations. Mr. Schoonmaker will be pleased to send samples to anyone interested, on application.

A NEW TYPE of shadeholder called the "Ideal" is being introduced by the Central Electric Company, Chicago. It is said to be ideal in many respects, its advantages being that it is made from one piece of metal and so constructed that it will not get out of shape.

MR. BEN F. LAMBORN, city clerk of Alameda, Cal., desires copies of catalogues and other information touching on electric lighting and electric railway equipment, construction, cost, etc. It is proposed to draw up a set of specifications upon which bids will be invited.

THE CATALOGUE of electrical supplies issued by J. Frank Eline, 206 East Baltimore Street, Baltimore, Md., is a very complete production of its class. It contains 224 pages, and covers every branch of applied electricity, and is, besides, very profusely illustrated. The prices of the various articles are also given.

THE CENTRAL ELECTRIC COMPANY, Chicago, announces that it will have a great variety of all kinds of portable reading and desk lights. The adaptation of these lamps to so many different purposes has resulted in the production of a wide variety of types. These and many other useful articles will be fully illustrated in the Central Electric Company's new catalogue, which is about ready for distribution.

MESSRS. GEORGE C. HOFFMAN AND THEODORE W. KLOMAN, 39 Cortlandt Street, New York, who represent the Northern Electric Manufacturing Company, of Madison, Wis., have secured the Eastern agency for the sale of the inductor alternators manufactured by the Warren-Medbery Company, of Sandy Hill, N. Y.

THE UNITED STATES CARBON COMPANY, Cleveland, Ohio, reports that it is meeting with great success in the manufacture and sale of its carbons for enclosed arc lamps, which seem to meet a large demand for an efficient domestic carbon to replace the imported article. Its large presses have been very busy on carbons for electro-metallurgical and electrolytical purposes.

THE MANHATTAN ELECTRICAL SUPPLY COMPANY, 32 Cortlandt Street, New York, has just issued its illustrated catalogue No. 10 of electric light, household, telephone and telegraph supplies. The catalogue, which contains 336 pages, very completely covers these departments of electrical application, and is well arranged with a view to quick reference.

A LOCKING OR CLAMPING SWITCH.—Mr. F. A. La Roche, of F. A. La Roche & Co., of New York, was granted patent No. 613,688, on November 8, for a locking or clamping device for binding the jaws and hinges to the blades of knife switches in the closed position, these clamping devices being set and released by the motion of the switch blades themselves.

A LARGE ORDER FOR TELEPHONE APPARATUS.—The Pennsylvania Electric Company, Marietta, Pa., recently received what it claims to be the largest single order ever given by an independent telephone company for apparatus. The order calls for 2000 Crescent Ideal telephones, which are manufactured by this company, and a 1000-line switchboard of the latest improved pattern.

THE ILLINOIS ELECTRIC COMPANY, Chicago, Ill., states that its sales of Crefeld weatherproof magnet, office and annunciator wires are increasing from month to month, and claims to carry one of the largest and most complete stocks of wire in Chicago. It invites correspondence from the trade when anything in its line is desired, and advises purchasers to secure its quotations before placing their orders.

THE JEFFREY MANUFACTURING COMPANY, Columbus, Ohio, has recently taken up the manufacture of the Columbian separator-screen and bolter, and has erected an experimental machine at its works for testing of such material that may be sent to it for that purpose. Those interested in the screening and separating of cement, clinker, coal, etc., can secure further information by addressing the Jeffrey Company.

THE BATTLE CREEK STEAM PUMP COMPANY, Battle Creek, Mich., manufactures the Marsh steam pump, which is adapted to all duties. It is stated to be absolute in action and regulation. In the catalogue of this company is shown a very complete line of these pumps, for all purposes, each type being well illustrated and briefly described. A copy of this catalogue should be in the hands of all steam users.

THE CENTRAL ELECTRIC COMPANY, Chicago, announces that it is making great preparations for the usual holiday trade in miniature lamps for decorative purposes. It is carrying large stocks of these lamps in clear glass and natural colors in all candle powers and voltages. It is also introducing a new type of standard-base miniature lamp, operative upon circuits of 90 to 130 volts. Its small dimensions render is particularly adapted to sign work and most all kinds of decorative purposes.

"THE MODERN ROUND-HOUSE TURNTABLE" is the title of a handsome pamphlet issued by the Westinghouse Electric & Manufacturing Company. In THE ELECTRICAL WORLD of August 27, 1898, was described and illustrated the electrically driven turntable which forms the subject of this pamphlet. The Westinghouse method of appling electricity to the operation of turntables should be especially interesting to railroad managers, inasmuch as it requires no change in the turntable proper other than attaching the draw-bar lug to the turntable girder.

MR. WILLIAM ROCHE, 259 Greenwich Street, New York, states that the English trade is taking a decided interest in his new "Standard" dry battery, which type of cell was used on the machine guns of the United States Navy in the war with Spain. During the past week he has made two large shipments to England, and reports the receipt of flattering orders for the cells. The oval or vest-pocket cell, he states, is also meeting with great favor. In order to keep up with the orders for these dry batteries, Mr. Roche has been compelled to run his shop, which occupies two floors, overtime.

THE MANSFIELD TEMPERED COPPER COMPANY, Mansfield, Ohio, states that its business is on the increase, and present indications are that its agents at Kendal, England, and Vienna, Austria, will tax the capacity of the present plant to keep them supplied with its products. Among the recent foreign orders were several for Messrs. Siemens & Halske, of Vienna; one for 7000 bars, one for 7500 and another for 2000, and the company is about to close an order for 50,000 street railway segments. Its agents at Kendal are using from 500 to 1000 a week. This, with the continually increasing home trade, will compel the company to again enlarge its producing capacity in the near future. It is less than a year ago that it was obliged to extend its plant.

THE EASTERN TELEPHONE MANUFACTURING COMPANY, of Meriden, Conn., is placing on the market first-class telephone apparatus at the lowest possible prices, at which the various instruments can be made and sold. The principal reasons given by the company why these instruments can be sold at such low figures are that its business is done on a cash basis—selling for cash and buying for cash—it has no agents on the road and makes a limited number of styles of telephones. Everything has been standardized so as to avoid waste and loss in manufacturing the instruments, which are produced in large quantities; this also lessens the cost. The company invites a trial of its instruments, feeling confident that satisfaction will be given.

GAS AND GASOLINE ENGINES.—The Webster Manufacturing Company, Chicago, Ill., in a pamphlet recently issued describes and illustrates artistically the Webster vertical 2½-hp gas engine. This engine, which is very compactly built, is especially adapted for running pumps, blowers, etc. The Webster horizontal gas and gasoline engine constitutes the subject of another catalogue issued by the same company. Six sizes of the engine of the horizontal type are manufactured, ranging in actual horse-power from 4 to 28. These machines are adapted to the running of dynamos, blowers, ventilating fans, passenger and freight elevators, etc. Among the illustrations shown in the catalogue are small electric-light plants driven by the Webster horizontal engines.

THE PERFECTION DYNAMO BRUSH.—The Ohio Electric Specialty Manufacturing Company, Troy, Ohio, reports that it is making large sales to both supply houses and consumers of its style of brush known as the "Type D Perfection." The brush is composed of a specially prepared wire gauze and a sufficient amount of leaf copper for backing, lubricated with graphite and covered in a way which prevents excessive sparking at the commutator end. It is, besides, noiseless, and said to have long wearing qualities, and aids in keeping the commutator in good condition. The company states that the high quality of this brush is attested by numerous duplicate orders being placed by satisfied customers. Descriptive circulars, prices and other information will be forwarded to those interested on application to the company.

THE SEASON for Christmas decorations is always a busy one for the contractor and electric light station manager, as nearly all such decorations mean some kind of special electrical illumination. The Packard sign lamp is designed with a view of meeting the demand for a lamp of uniform candle-power, voltage and efficiency for this class of work, and it is now very extensively used for decorative purposes. It is a miniature lamp of two candle power, to be used in connection with a regular Edison candelabra receptacle and of a proper voltage to burn four in series on from 50 to 60 volts and eight in series on from 100 to 120 volts. Long life and high efficiency are guaranteed. The Electric Appliance Company, Chicago, carries these lamps and receptacles in stock at all times, but has a specially large stock at this season of the year to meet the unusual demand.

AN IMPROVED BRUSH HOLDER.—Mr. A. E. Doman has been granted patent No. 613,669, issued November 8, 1898, on an improved brush-holding mechanism, the patent being assigned to the Elbridge Electrical Manufacturing Company, Elbridge, N. Y. The arrangement consists, in short, of a radial brush mounted on a holder swiveled on the usual pivot or spindle on the rock arm, and provided with a ball and socket or universal joint near the brush itself. The purpose of this is to prevent the oscillations of the holder as the brush rises and falls due to the irregularities in the commutator surface from teetering the brush around the pivot and causing it to make contact at its edges instead of over its whole face. The ball-and-socket joint allows a small universal movement by which the surface of the brush pressing on the commutator can adjust itself to a true bearing at all times.

NON-MAGNETIC WATCHES FOR ELECTRICAL MEN.—In electric light and power stations where electric generating machines are in operation the magnetism which permeates the air is extremely detrimental to watches. The ordinary watch invariably becomes magnetized and is rendered useless as a time-keeper. The Paillard non-magnetic watch is said to be absolutely proof against the harmful effects of magnetism and electric currents. It has been on the market for several years, and established its reputation on this fact principally, although it is said to be a first-class watch in every other respect. Dynamos and other electrical apparatus may be approached with impunity without fear of damage to the delicate mechanism. The manufacturer of the Paillard non-magnetic movement is Mr. A. C. Becken, 103 State Street, Chicago, Ill. Mr. Charles R. Randall, 54 Maiden Lane, New York City, is the selling agent.

THE EMERSON ELECTRIC MANUFACTURING COMPANY, 714-718 St. Charles Street, St. Louis, Mo., is making a specialty of the direct connection of electric motors to all classes of light machinery, and is prepared to furnish alternating-current power motors in all sizes from one-thirtieth actual horse-power up to 30 horse-power. Over one hunded different kinds of alternating-current motors are mandfactured regularly by this company, which claims that it is in a better position than any other company in the United States, or possibly in the world, to furnish users of alternating-current power motors with their exact requirements. All of the products of its factory are thoroughly guaranteed, and if prospective customers have any doubts as to the practical working of single-phase alternating-current machinery the company is perfectly willing to send machines to responsible parties on ten to thirty days' trial. The company asks that in such cases it be advised definitely and in detail just the kind of work the motor will be called upon to perform. This company has had a large amount of experience in all classes of small power work, and invites correspondence from either manufacturers, consumers or electrical dealers who have had difficulty in finding the proper electric motor for use on alternating current. In addition to motors the Emerson Company manufactures a complete line of knife switches, switchboards, tablet boards, etc. Catalogues and printed matter describing its products will be furnished to the trade or direct to the consumers on application.

Business Notice.

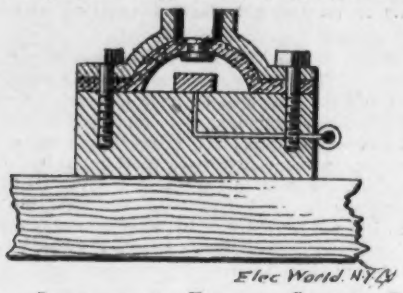
THE ILLUSTRATIONS in this issue were made by the Photo-Engraving Company, 9-15 Murray Street, New York City.

UNITED STATES PATENTS ISSUED NOVEMBER 15, 1898.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

614,076. ALTERNATING-CURRENT MOTOR AND MODE OF OPERATING SAME; Chas. S. Bradley, of Avon, N. Y. App. filed June 22, 1896. An alternating-current motor having a winding on one element connected with a single-phase supply-circuit, a polyphase winding on its cooperating element, and a variable-speed generator supplying the latter with polyphase currents of variable rates.

614,082. INTERMITTENT ELECTRIC SURFACE CONDUCTOR; F. Burger, of Ft. Wayne, Ind. App. filed July 23, 1897. An intermittent elec-

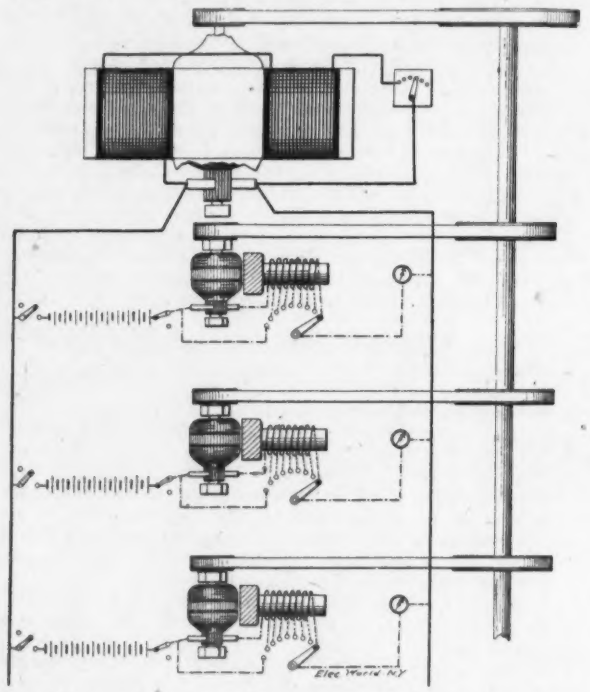


No. 614,082.—Intermittent Electric Surface Conductor.

tric surface conductor, comprising a stringer mounted on the cross-ties, a feeding conductor supported on the stringer, a flexible covering for the conductor secured to the stringer and having a series of contact pieces extending through the covering, channel irons arranged on each side of the flexible covering and secured to the stringer leaving a slot between their adjacent edges, and insulating material applied to the adjacent edges whereby when the trolley wheel passes through the slot the contact pieces are pressed into engagement with the feeding conductor, and rise therefrom by the resiliency of the covering, substantially as described.

614,124. ELECTRIC SWITCH MECHANISM FOR ELECTRIC RAILWAYS; J. M. Murphy, of Torrington, Conn. App. filed Sept. 3, 1897. An electromagnetic switch mechanism of the character stated, comprising electromagnets, an armature switch, a main-line circuit having contacts adapted to be engaged and closed by the shifting of the armature switch, a local circuit for energizing the magnets to throw the switch, said local circuit having a contact member continuously held in engagement with the switch during its vibrating movement.

614,207. TELEPHONE EXCHANGE SYSTEM; W. E. M. Jackson, of Chicago, Ill. App. filed Jan. 14, 1896. In a telephone exchange system sev-



No. 614,228.—Method of Charging Secondary Batteries.

eral transmitting devices, line circuits for each, normally open, and a receiving device common to the several transmitting devices and combined with a selective device controlling the signals from said transmitting devices, substantially as described.

614,208. TROLLEY; F. A. Le Court, of Rockport, Mass. App. filed June 17, 1898. In a device of the character described, the combination of a trolley-wheel concaved at its ends, a trolley pole, a bracket mounted on said pole and having provisions for journaling said wheel, said bracket being provided with side flanges fitting within the concaved ends of the wheel, and engaging the rims thereof inside of the outer edges of the latter, substantially as described.

614,225. ELECTRIC METER; L. Gutmann, of Peoria, Ill. App. filed Dec. 4, 1897. An armature for electric meters, consisting of two rings of electrical conductors and conducting strips angularly disposed to said rings connecting them to one structure.

614,228. METHOD OF CHARGING SECONDARY BATTERIES; C. O. Mailloux, of New York. App. filed April 24, 1891. The method of charging secondary batteries which consists in producing progressive changes of supplemental e. m. f. acting with an e. m. f. in the circuit of said battery, and in accordance with and progressively graduated to the progress of the charge, and increases of counter e. m. f. in said battery.

614,270. INSULATED SUPPORTER FOR ELECTRIC OR OTHER WIRES; C. K. King and G. A. Mead, of Mansfield, Ohio. App. filed June 29, 1898. In a support for trolley wires and the like, a clamp or ear, a hanger body, including an insulator washer, a threaded stud-bolt mounted therein and adapted to be screwed into said clamp, and a lock washer interposed between said insulator washer and clamp.

614,275. APPARATUS FOR HEATING AND AGITATING AIR; E. F. Porter, of Boston, Mass. App. filed Dec. 27, 1897. In an apparatus of the character specified, a series of plates, means for heating said plates, and mechanism for operating one or more of said plates relatively to each other to agitate the surrounding air.

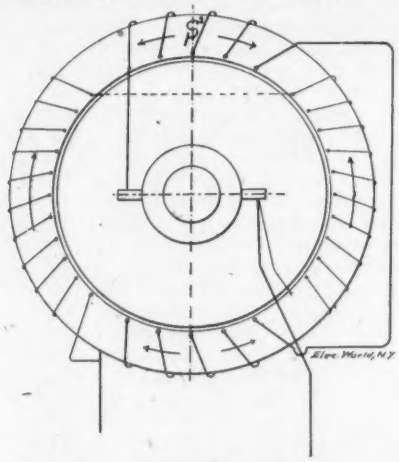
614,318. PORTABLE ELECTRIC LAMP; O. T. Bugg, Jr., of New York, N. Y. App. filed March 15, 1898. A portable electric lamp consisting of a single conducting casing carrying an electric lamp, one terminal of which is in permanent electrical contact therewith; an interior non-conducting lining and one or more battery cells, one electrode of which is connected to the conducting casing together with an insulated conductor adapted to be connected to the remaining terminal of the lamp, and a thumb knob or switch adapted to cause the free end of said conductor to bear against the remaining terminal of the lamp, substantially as described.

614,321. TROLLEY CONTROLLER; J. Dolan, of Dayton, Ohio. App. filed April 23, 1898. In a trolley controller, the combination with the trolley rope, of means for pulling said rope down when the trolley jumps the wire, and a pull cord provided at its upper end with a yoke carrying a roller, said rope passing through the yoke, thereby a downward pull on said cord restores the rope to its normal position after being pulled down.

614,339. ELECTRIC ACCUMULATOR; F. Pescetto, of Turin, Italy. App. filed Dec. 24, 1897. An electrode for secondary batteries having an active mass containing ulmate of ulmin.

614,373. ARRANGEMENT FOR EXCITING MAGNETS OF DYNAMO MACHINES; M. Deri, of Vienna, Austria-Hungary. App. filed July 27, 1898. In a dynamo machine having a commutator armature, a field magnet arranged around the armature in such a way that the iron of the magnet is equally distributed around and equidistant from the armature, there being two groups of excitation coils having an equal number of poles, and the polar divisions being displaced mutually through half a pole distance, substantially as described.

614,394. STARTING RESISTANCE FOR ALTERNATING-CURRENT MOTORS; E. L. Karl and F. Kahlenberg, of Berlin, Germany. App. filed Dec. 30, 1897. The method of effecting the control of alternating-current dynamo-electric machines, which consists in altering symmetrically the several groups of resistance connected in the individual circuits of said dy-



No. 614,373.—Arrangement for Exciting Magnets of Dynamo Machines.

namo-electric machine, whereby its operative condition is governed, substantially as described.

614,404. SIGNALING APPARATUS; M. Hartin, Malden, Mass. App. filed Sept. 28, 1885. In a signal-transmitting system, a signal transmitter at one station comprising variable signal-determining devices, a receiver at a second station for reproducing the signal determined at the first station, circuit connections and a device at the receiving station for controlling the reception of the predetermined signal, said device being as to its time of operation, independent of the transmitter.